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Science & Technology

USSR: Space

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Destructive Reentry of 'Progress-M3'

LD2804094590 Moscow TASS in English 0934 GMT 28 Apr 90

[Text] Flight Control Center April 28 TASS—The unmanned cargo spacecraft Progress M-3, which was launched on March 1, was destroyed today after completing its mission.

The craft had taken some 2.5 tons of freight to the orbiting platform Mir (Peace), where two cosmonauts are currently posted. The spacecraft's propulsion unit after docking was fired to adjust the platform's orbit.

After being jettisoned from Mir by commands from the Flight Control Center on Friday, Progress M-3 was directed into a descent today. It burnt up after entering the dense layers of the atmosphere over a preset area in the Pacific.

The two cosmonauts, Anatoliy Solovyev and Aleksandr Balandin, meanwhile, carried out several technical experiments in the past few days. In one experiment, equipment installed on the outer wall of the service module Kvant-2 (Quantum-2) was used to study the characteristics of various materials in raw space.

The cosmonauts' work is proceeding as planned.

Both men are in good health and feeling well.

'Kristall' Module Launch Set for 1 June

LD0405082590 Moscow TASS in English 0711 GMT 4 May 90

[Text] Moscow May 4 TASS—June 1 has been named as the deadline for the eventual launch, after a number of postponements, of the Kristall technolgical module, TASS was told by Aleksandr Aleksandrov, chief of the Civil Cosmonauts Service.

Aleksandrov, who has been on space missions twice himself, recalled that it had first been decided to launch the module, which will work as part of the Mir complex, on April 18. The start was postponed, with the module sitting at the Baykonur Space Center, because problems arose relating to its reception by Mir station.

Soviet cosmonauts Anatoloy Solovyev and Aleksandr Balandin, who have been working on board the orbital complex for nearly three months now, are looking forward to the arrival of the new module—a microfactory for producing crystals in weightlessness, which would considerably expand research prospects in the field of space technologies.

According to Aleksandrov, the two cosmonauts are now busy putting into service as new powerful on-board computer. It has been decided tht the cosmonauts should first receive another ferry-craft and then continue testing the computer. The Kristall module will be launched after that.

The present crew will have enough time to carry out some technological experiments before the term of their mission expires and another crew arrives to take over.

'Progress-42' Cargo Ship Launched

LD0505230790 Moscow TASS International Service in Russian 2124 GMT 5 May 90

[Text] [no dateline as received] In line with the program for the further work of the "Mir" scientific and research complex, the launch of the Progress-42" automatic cargo ship was carried out in the Soviet Union at 0044 [2144 GMT] on 6 May 1990.

The purpose of the ship's launch is to deliver materials that are being depleted and various cargoes to the "Mir" manned complex. The "Progress-42" ship has been placed in an orbit with the parameters:

apogee—261 kilometers;
perigee—194 kilometers;
period of revolution—88.7 minutes;
inclination—51.6 degrees.

According to telemetry information, the on-board systems of the automatic cargo ship are working normally.

'Progress 42' Docks With 'Mir' Complex

LD0805010190 Moscow TASS International Service in Russian 0006 GMT 8 May 90

[Text] Moscow, 8 May (TASS)—The docking of the Progress-42 cargo craft with the "Mir" manned complex was accomplished at 0245 Moscow time on 8 May [2245 GMT 7 May].

The mutual search, rendezvous, approach, and docking were carried out with the aid of on-board automatic equipment. These processes were monitored by the Flight Control Center and also by cosmonauts Solovyev and Balandin.

The Progress-42 craft was docked to the complex at the Kvant module. Fuel for the station's combined power plant, foodstuffs, water, equipment, apparatus, and mail were delivered into orbit.

According to data from telemetry information and to the crew's reports, the on-board systems of the "Mir" manned complex are working normally. Anatoliy Solovyev and Aleksandr Balandin feel well.

Cosmonauts Continue Materials Processing, Await 1 Jun Module Launch

LD0805082390 Moscow TASS in English 0803 GMT 8 May 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow May 8 TASS—Soviet cosmonauts Anatoliy Solovev and Aleksandr Balandin, who have been working aboard the orbital complex "Mir" for almost

three months now, have launched a new technological experiment with the Gallar plant. The purpose of the experiment is to obtain zinc oxide in zero-gravity conditions.

Prior to this, they completed a lengthy experiment to grow gallium arsenide monocrystals. This experiment was begun by the fifth resident crew—Aleksandr Viktorenko and Aleksandr Serebrov, who were replaced by Solovev and Balandin. In all, 297 grams of gallium arsenide were obtained with the Gallar plant, TASS was told at the USSR Chief Space Administration (Glavkosmos).

Specialists at the Nauchnyy Tsentr science and production association in the city of Zelenograd near Moscow are currently conducting the analysis of this valuable composite material needed by the radioelectronic industry.

According to tentative estimates of foreign scientists, these materials obtained in zero gravity conditions may cost 3.5 million dollars per kilogram on the world market.

When the Kristall technological module is launched, possibilities for space technology will be appreciably boosted. The Kristall module is scheduled for lift-off 1 June 1990. This module, a kind of a microplant to obtain crystals in space conditions, will operate as part of the "Mir" orbital complex.

Crew Completes Third Month Aboard Mir Complex

LD1105082490 Moscow TASS in English 0718 GMT 11 May 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow May 11 TASS—Soviet cosmonauts Anatoliy Solovyev and Aleksandr Balandin have worked in space for three months. They have carried out an extensive program of technological, astrophysical, geophysical and medico-biological research and experiments in the interests of various branches of the economy.

A few days ago, Solovyev and Balandin began unloading the Progress-42 ferry craft, which docked with the orbital complex on May 8. The ferry had brought fuel, equipment, foodstuffs, water and mail.

In early May, the cosmonauts completed a long-term technological experiment—a gallium arsenide monocrystal had been created, and began a new experiment of the same series, designed to obtain zinc oxide, another valuable semi-conducting material.

Using the Mariya spectrometer they carried out a number of experiments to study the generation and proliferation of elementary high-energy charged particles in near-earth space.

Extensive work has been done to study the earth's natural resources for various organisations.

Visual observation from space reinforces instrumental measurement in a number of cases.

Solovyev and Balandin are now getting ready to receive the Kristall technological module—a kind of microfactory to produce crystals in weightlessness. Its launch was put off several times and is now expected to take place on June 1, so that the present crew will have time to start the space factory before the term of their missions in space expires.

Report on Soyuz Damage Threatening Crew's Return Denied

PM1905153790 Moscow IZVESTIYA in Russian 20 May 90 Morning Edition p 1

[Report by V. Romanyuk: "Flight Continues Without Sensational Incidents"]

[Text] "Work in orbit is continuing in routine fashion," your IZVESTIYA correspondent was told by Yuriy Serebryannikov, "Soyuz" transport craft flight leader. "Nothing special has happened. The cosmonauts made routine contact at 1219 hours."

Our call to Central Flight Control was prompted by the fact that REUTER, citing AVIATION WEEK AND SPACE TECHNOLOGY, had transmitted the latest "sensation" about incidents in space. The report went literally as follows: "The two cosmonauts on board the Soviet 'Mir' orbital space station are left without a realistic chance of returning to earth. They are preparing to leave their steel sanctuary and make an emergency spacewalk." Further on it is claimed that the "Soyuz" spacecraft that is docked with the station needs repairs.

"Soyuz" transport craft flight leader Yuriy Serebryannikov said that REUTER was not alone in airing the "sensation." He had just been shown a PRENSA LATINA reoport saying that the temprature on board the spacecraft had risen sharply.

So are they all canards, then? Not entirely. Vacuum insulation baffles [ekranno-vakuumnaya isolyatsiya] have peeled off the outer casing of "Soyuz," and this was clearly visible during the television report from space.

"Could the fact that the craft is in this condition affect the solution of the problem of bringing the cosmonauts back to earth?"

"No way," was the brief reply.

Spacecraft May Be Repaired By Cosmonaut EVA

LD2005073290 Moscow World Service in English 0700 GMT 20 May 90

[Text] The Flight Control Center had denied reports that a fault aboard the Mir orbital station may prevent the two cosmonauts from returning to earth on schedule. An

article in the American weekly AVIATION [WEEK] AND SPACE TECHNOLOGY claims that the Soyuz spacecraft docked to the station needs major repairs, which cannot be done now and this may delay the planned return of the crew.

One of the leaders of the flight, Yuriy Serebryannikov, said the work of the cosmonauts is continuing normally. At the same time he confirmed that an insulation layer on the spacecraft's coating had come off. As a result, during their next operation in open space the cosmonauts may be asked to mend the place.

Cosmonauts Complete 100 Days in Space

LD2205132190 Moscow TASS in English 1253 GMT 22 May 90

[Text] Moscow May 22 TASS—TASS correspondent reporting from the Mission Control Center:

Anatoly Solovyev and Aleksandr Balandin have spent 100 days in near-earth orbit.

The flight program of the "Mir" complex early this week includes astrophysical and geophysical research, and experiments involving space technology and biology.

With the help of the "Glazar" telescope, which registers radiation in the ultraviolet part of the spectrum, the cosmonauts yesterday took pictures of the sky in the area of the Southern Crown constellation.

Another monocrystal of the semiconducting material, gallium arsenide, was obtained on the "Gallar" device.

On April 21 experiments were started on the "Arfa" equipment, attached to the outside surface of the "Kvant" module to pursue further study of earth's ionosphere and magnetosphere. One of the immediate goals of this research is to determine the possibilities of orbiting information on tectronic processes in the earth's crust by sounding out the upper layers of the ionosphere.

Studying the earth's natural resources and the environment, the cosmonauts today will hold a series of experiments using a video-spectral complex, mounted on the gyrostabilizing platform of the "Kvant-2" module. They are to take pictures of the ocean.

During the day the crew will also study peculiarities of electrochemical processes in zero-gravity with the help of the "Sigma" device.

As planned, fuel tanks of the station will be refuelled with oxidizer with the help of the "Progress-42" cargo spacecraft.

According to telemetric information and crew reports, the on-board systems and scientific equipment of the manned complex "Mir" are functioning normally. The cosmonauts feel well.

Flight 'Going According to Program'

PM2205135590 Moscow PRAVDA in Russian 22 May 90 Second Edition p 3

[Text] The reports in a number of foreign mass media of a possible breakdown [avariya] aboard the Soviet orbiting space complex "Mir" are unfounded.

As your TASS correspondent was informed at the Flight Control Center, the flight of the "Mir" orbiting complex is going according to program. The crew is preparing for the "Kristall" module to join the station. The launch of the "Proton" booster rocket carrying the "Kristall" module from the Baykonur space center is scheduled for 31 May or 1 June.

"There has been no breakdown aboard the station," V. Blagov, deputy flight director, said. "The week-long 'solar' attitude flight, as it is known, ended recently. During that time the surface of the station was continuously illuminated and warmed by the sun. But this is a standard regime included in the flight plan. The heat regulation system maintains a temperature of 26 degrees Celsius within the station's compartments. During a normal flight regime this temperature is around 24 degrees."

Foreigners Said to 'Feed Fears Over Soyuz'

LD2205185190 Moscow TASS in English 1806 GMT 22 May 90

[Text] Moscow May 22 TASS—By TASS correspondent Rena Kuznetsova:

Anatoliy Solovyev and Aleksandr Balandin, the crew of the sixth main space expedition, are scheduled to return to earth on July 29, this year, deputy director of the mission Viktor Blagov told TASS.

"We are not concerned about the condition of the orbital space complex Mir as a whole and the Soyuz TM-9 transport spacecraft in particular. The present crew has been working aboard the Soyuz craft for more than 100 days now," he said.

"I am surprised at the concern shown by foreign news agencies over the safety of the Soyuz craft," Blagov said. He believes that their assertions that the two cosmonauts have remained stranded in space—"without a reliable escape vehicle"—are not only unfounded but are simply incorrect.

"It seems to me that our foreign competitors are deliberately blowing the entire affair out of proportion and feeding fears over the Soyuz craft," Blagov went on to say.

"Not everyone abroad likes the fact that in recent years the Soviet Union has flung the 'space gate' wide open for international cooperation in the peaceful study and use of the near-earth space.

"We invite the whole world to start work on joint space missions, to deliver cargoes to orbit and launch various satellites, and we are prepared to provide the high-powered space booster rocket Proton for the purpose.

"Ever since the flight by the world's first cosmonaut Yuriy Gagarin, the Soviet Union has regarded its achievements in space as an asset of all mankind."

Returning to the current flight, Blagov recalled that damage to the shield-vacuum insulation was detected when the Soyuz TM-9 craft was docking with the orbital complex Mir.

Several days later, the damage was reported on Soviet Television, a qualified explanation, and the damage was said to pose no danger to the cosmonauts' return to earth.

"It is unclear why Western media suddenly picked up the report now, showing their concern for the life of the Soviet space crew after more than three months have passed," Blagov said.

"This was prompted most probably by a report in the American AVIATION WEEK AND SPACE TECHNOLOGY journal, which decided to offer 'sensational news' from the Soviet orbital complex Mir, when the crew is marking 100 days in weightless conditions.

"Immediately following the docking, the cosmonauts thoroughly examined the craft," Blagov said. "We saw that all parameters were normal. The cover, which is designed to help curb the extreme temperatures during flight, had come loose.

"As a specialist I know that the three loose thermal blankets do not play any significant role in stabilising the craft's temperature conditions.

"By orienting the station with respect to the sun we selected temperature modes: one third of the day the complex is heated by the sun, during another third the flight is made in its shadow and the rest of the time in a moderate zone.

"The thermal regulation system makes it possible to maintain normal temperature inside the compartments of the orbital complex. The insulation will be secured back in place during a spacewalk."

Destructive Reentry of Progress-42

LD2705164590 Moscow TASS in English 1549 GMT 27 May 90

[TASS special correspondent report from Mission Control Center]

[Text] Moscow May 27 TASS—The space mission of the Progress-42 unmanned spacecraft has ended. It brought to the Mir space station some two tons of cargo.

At 11:09 the spacecraft was undocked from the manned space complex. At a calculated time it was transferred to the descending trajectory, entered thick layers of the atmosphere and ceased to exist.

Today's program of the space crew includes geophysical experiments and planned maintenance work with the equipment of the life-supporting system. In the afternoon Anatoliy Solovyev and Aleksandr Balandin began preliminary conservation of the Soyuz TM-9 spacecraft before the redocking of the airlock of the basic unit to the docking unit of the Kvant module.

According to the telemetric information and reports of the crew, the flight is proceeding according to the program. The cosmonauts are in good health and feel well.

Cosmonauts Redock Soyuz TM-9

LD2805223890 Moscow TASS in English 1914 GMT 28 May 90

[Text] Mission Control Center May 28—Manned flight of the Mir research complex continues.

In accordance with the program, Anatoliy Solovyev and Aleksandr Balandin carried out today the redocking of the Soyuz TM-9 spacecraft from the airlock of the complex to the docking unit of the Kvant astrophysical module. The orbital complex was rearranged in order to be ready to handle the specialised technological module Kristall, which is to be launched on May 31, 1990.

Before the undocking the commander and the flight engineer moved to the transport spacecraft and sealed hatches. At 15:48 Moscow time the two space vehicles were separated. The crew conducted maneuvering on orbit, including a flight around the research complex, rapprochement and docking using a manual control system. The flight of the Soyuz TM-9 lasted for 24 minutes.

On all the stages of redocking on-board systems of the space vehicles functioned normally.

TASS Reports Launch of 'Kristall Module 31 May

LD3105200890 Moscow TASS International Service in Russian 1600 GMT 31 May 90

[Text] Moscow, 31 May (TASS)—The specialised "Kristall" module, weighing about 20 tons, were put into earth orbit from Soviet territory today, in accordance with the program for space research. The module was placed in orbit by a "Proton" carrier rocket. This is the third module for use in conjunction with the "Mir" multipurpose research complex.

The "Kristall" module is designed for experimental industrial production of semiconductor materials; the purification of biologically active substances with the aim of obtaining new medical preparations; the cultivation of crystals of various proteins; the hybridization of cells; and also for astrophysical, geophysical, and technical experiments.

Apart from its main docking port, the specialised "Kristall" module is equipped with two peripheral-androgynous docking units, one of which is intended for joint use with the "Buran" orbital shuttle.

According to telemetry information, the systems on board the module are functioning normally. The paremeters of its orbit are as follows:

Maximum distance from the earth's surface—346 km
Minimum distance from the earth's surface—220 km
Period of orbit—89.9 minutes
nclination—51.6 degrees

The docking of the "Kristall" module with the manned "Mir" complex is scheduled for 6 June.

Features of 'Kristall' Technology Module

907Q0067A Moscow KRASNAYA ZVEZDA in Russian 4 Apr 90 First Edition p 3

[Article by Colonel M. Rebrov: "On the Shore of the Ocean of Weightlessness: A New Space Module Being Readied for Launch at Baykonur"]

[Text] Time is flying by at astonishing speed. Fifteen or 20 years ago the very titles "Plants in Space" and "On the Shore of the Ocean of Weightlessness" would have been the prerogative of science fiction writers alone. Serious-minded people preferred not to talk about "space production," but about ordinary production here on earth. Soon everything changed, however, and the words "Vulkan [volcano]," "Splav [alloy]," and "Kristall [crystal]" appeared in our lexicon, filled with space-production meaning. These are the names of the experimental technology units which mark the beginning of our more large-scale orbital laboratories.

The history of technology is replete with examples showing how the employment of new principles led to a radical restructuring of entire branches and brought about great economic benefit, as well as having social effects. We recall the arrival of the jet engine in aviation, the electric train on the railroad line, the birth of atomic energy, the computer, new materials... Space exploration has presented us with fundamentally new opportunities for solving the most pressing problems of our time in the most diverse spheres of science and the national economy. An example of this can be seen in the special-purpose Kristall module, whose launch from Baykonur is tentatively scheduled for 9 April, although this date may change. Following a week-long flight, the module should dock with Mir.

This module is called a technological module—it is intended to conduct an extensive series of experiments and research dealing with the study of materials in space. But this is the scientific portion of the program. There is also an economic side—the beginning of experimental industrial production of high-quality (essentially unique) semiconductor materials to meet the needs of microelectronics. Experts describe the goal of this effort as "a search for optimal parameters in technological processes, allowing us to obtain materials with enhanced characteristics as compared with earth technology, or entirely new materials."

Let me say again that the essence of space technology lies in the fact that the particular conditions existing in near-earth orbit (weightlessness, deep vacuum, space radiation, and other factors) cause a number of physical processes to occur differently in space than they would on earth.

K.E. Tsiolkovskiy was the first to mention "the benefits of space." And the first patent on the use of weightlessness was obtained by the Englishman William Watt. This was over two centuries ago when the very concept of "space" did not exist as we presently understand it. The talented inventor noticed that during the process of free-fall from a high tower, droplets of lead acquired a circular form. The idea that "this is how shot can be cast" flashed through his mind, and he was awarded a patent. Today we know that free-fall can be considered a short-term form of weightlessness...

But let us return to the new module, which can rightly be termed a plant in space. Installed on it are the technological units "Krater-3," "Optizon-1," "Zona 02," and "Zona 03," designed for experimental industrial production of semiconductor materials. There is another apparatus here as well, but it must be treated specially.

And the module itself? Externally it is similar to Kvant-2. Its mass in orbital configuration is 19.5 tons (the launch mass is greater due to fuel). The module casing length is 11.9 meters, maximum diameter—4.35 meters, useful payload delivered into orbit (equipment, etc.)—7 tons.

The module consists of two hermetically sealed compartments—the instrumentation-cargo compartment and the transfer-docking compartment. There is an access hatch between them that is 0.8 meter in diameter. A portion of the "floor" and "ceiling" paneling of the first compartment (as in the Kvant-2 supplementary-equipment module) has been taken up by payload containers for storing food rations.

The second compartment is in the shape of a cylinder joined to a sphere that is 2.2 meters in diameter. Instrumentation units are affixed to the cylinder's internal surface, and the working area of the "sphere" is partially occupied by two docking assemblies. A photographic compartment with camera equipment is installed in place of a third docking assembly.

One further particular feature of the Kristall module—mounted on it are two new APAS-89 androgynous-peripheral docking mechanisms (we recall the APAS-75 which was used for docking our Soyuz spacecraft with the American Apollo in the summer of 1975). Docking and joint operation of the Mir orbital complex with the Buran multiple-use spacecraft is planned for 1991.

Plants in space... No—today this is no longer science fiction. Soviet designers and engineers have built a laser kinescope which uses monocrystalline cadmium sulfide obtained in space. There is nothing analogous to this material on earth with respect to its specifications.

But how much of such materials do we need? The current annual demand by the Ministry of Electronics Industry, the Ministry of Electrical Engineering Industry, and the Ministry of Defense Industry for space-produced materials is measured in tons. The family of semiconductor instruments grows larger year after year. And this process will only keep gathering speed since microelectronics is capable of everything—from running a lathe to controlling a branch of industry. While the productivity of orbital plants is as yet limited to kilograms, a great future looms beyond space technology—its applications promise to provide an economic benefit of 400-800 million rubles per year.

And there is more. "Augmenting" the orbital space station is not an end in itself. Insofar as the tasks being accomplished during the research of space are planetary in scope, the significance of international cooperation here is great, more so than in any other sphere. The instrumentation mounted on Mir and two Kvant modules has been built by engineers and scientists of Bulgaria, the GDR, Czechoslovakia, the United States, France, and other countries. The "Rentgen" observatory is rightly termed international. Several expeditions have already taken place with the participation of foreign astronauts on Mir; and we are awaiting the launch of representatives of Austria, Great Britain, Japan, France...

At a March session of the science and technology subcommittee of the United Nations Committee on the Study of Outer Space for Peaceful Purposes, the Soviet Union proposed the conduct of scientific experiments on the Mir station and its modules developed by young scholars and students of the developing countries, in technology, biotechnology and medicine, astrophysics, natural history, the study of radiation in space, etc.

Final preparations at Baykonur are being completed. The Kristall module is in the installation-and-test building. After a certain amount of time, it will be mounted under the Proton rocket faring, and the launch vehicle itself will be moved out to the launch pad. A telephone conversation with the cosmodrome has confirmed that pre-launch preparations are proceeding as scheduled. We will be reporting the "contact separation" countdown—the hours, minutes, and seconds.

Equipment of 'Kristall' Module

LD3105184490 Moscow Domestic Service in Russian 31 May 90

[Editorial Report] Moscow Domestic Service in Russian at 1500 GMT on 31 May broadcasts a report by special correspondent Leonid Lazarevich on the flight of the 500-ton rocket carrying the Kristall module into space.

The correspondent notes that the module has now been in orbit for 3 hours and 30 minutes and it will take a week to reach the Mir station. The Kristall module weights 19 tonnes, including 10 tonnes of useful cargo, the correspondent notes, adding that useful cargo means: five furnaces for producing super-pure material needed in electronics; a "biotechnological installation" that will make it possible to obtain preparations and serums that will open up new possibilities in medicine; a new apparatus for studying the earth, which will, perhaps, help in forecasting earthquakes; and an "astrophysical apparatus" that will enable scientists to look into the depths of the universe.

The correspondent goes on to say that the most important thing is that once the module has reached the Mir station it will be possible to make all the Soviet space research on board Mir highly profitable. Kristall is called a "docking-technological" module, the correspondent notes. It has a further two docking ports which will enable the Buran shuttle craft to dock with Mir. Buran will be carrying a "special laboratory" which can be removed and docked with another docking port.

The correspondent concludes his report by noting that everything is proceeding smoothly and that the docking will take place on 6 June.

Cosmonauts Continue Work on 'Mir', 'Kristall' Systems 'Functioning Normally'

LD0106201290 Moscow TASS International Service in Russian 1110 GMT 1 Jun 90

[TASS correspondent's report from Flight Control Center]

[Text] Moscow, 1 Jun (TASS)—Anatoliy Solovyev and Aleksandr Balandin are continuing their work aboard the Mir orbiting complex. The scientific part of the crew's program for this week included geophysical, astrophysical, and technical experiments as well as medical research.

In recent days the cosmonauts have carried out several sequences in which they filmed the earth's surface, using videospectrometric equipment installed on the stabilized platform of the resupply module. An appraisal of atmospheric pollution over major industrial regions of the country was also carried out.

The "Mariya" magnetic spectrometer was used to carry out a series of experiments, one of whose purposes is to determine a possible connection between streams of elementary charged high-energy particles in space and seismic activity on earth.

In accordance with the extensive program of research on the earth's natural resources and environmental studies, the cosmonauts will today carry another series of remote sensing of specific areas of land and ocean. This work will be carried out with spectrometric equipment and the KAP-350 fixed topographical camera.

In accordance with the medical supervision plan Anatoliy Solovyev and Aleksandr Balandin will monitor their heart and vascular systems while taking exercise on their exercise bicycle.

Experiments to determine the impact of open space on various materials are continuing. Today, in particular, there are plans to study the characteristics of ferromagnetic materials. Samples of these are contained in equipment which is fitted to the outside of the "Kvant-2" module.

The flight of the specialized "Kristall" module, which was put into earth orbit on 31 May, is continuing. There are plans to make a course correction this afternoon in accordance with the program.

According to telemetric information, the systems on board the orbiting Mir complex and the specialized "Kristall" module are functioning normally.

'Kristall' Due To Dock 6 Jun

LD0506220790 Moscow TASS International Service in Russian 1350 GMT 5 Jun 90

[Report by TASS special correspondent from the Flight Control Center]

[Text] Moscow, 5 June (TASS)—Today the cosmonauts Anatoliy Solovyev and Aleksandr Balandin carried out a routine series of geophysical experiments in accordance with the program for researching the earth's natural resources and studying the environment. Using topographical apparatus and hand photographic cameras, photographs were taken of individual sections of the territory of the USSR along the route of the flight of the Mir orbital complex. The task of the research is to evaluate the ecological state of areas of agricultural lands, water basins and forest areas in the regions of the republics of central Asia, Kazakhstan and eastern Siberia.

During the day the cosmonauts will carry out general observations of the cardiovascular system and carry out a number of experiments to measure the level of ionizing cosmic radiation in near-earth space.

In accordance with the program of the flight of the Kristall specialized orbitAl module, another maneuver was carried out to bring it closer to the Mir manned complex. The calculated time of docking the space vessels is 1530 on 6 June.

The onboard systems of the Mir complex and the Kristall module are functioning normally.

'Kristall' Docking Postponed

LD0606115990 Moscow Domestic Service in Russian 1117 GMT 6 Jun 90

[Excerpts] [Announcer] Dear comrades, we are interrupting our musical program in order to go over to the Flight Control Center, where our special correspondent, Vladimir Bezyayev, is.

[Bezyayev] Hello, dear comrades. At this very hour and very minute I was to have begun a reportage on the start of the docking of the new technological module, Kristall, with the Mir orbital complex but, alas, this docking has been postponed due to technical reasons. An analysis of the situation is now being conducted and we will only find out when these [docking] procedures will be repeated after the specialists have summed up all the results and given their conclusions. And then we will be able to name the date and hour that these procedures will be repeated. [passage omitted on phone call to Flight Control Center by astrologist who claimed the docking would not take place at the scheduled time, and on difficulties encountered during docking of Kvant modules]

And so, I hope the situation will become clearer after 1600 [Moscow time] and I wil be able to give you more objective information on the what, why, and when. And so, until we meet again after 1600.

'Kristall' Computer Aborted First Docking Attempt

PM0706120390 Moscow Television Service in Russian 1700 GMT 6 Jun 90

[From "Vremya" newscast: Reportage from Flight Control Center by S. Slipchenko, identified by caption, on postponement of "Kristall" docking]

[Text] [Newscaster] The flight of the "Mir" orbital station is continuing. A docking between the station and the "Kristall" module, launched into space 31 May, was scheduled for today. Here is a reportage from the Flight Control Center:

[Slipchenko, facing camera] In journalism there is a sacred commandment which says: "Take care not to cause harm with your information." This is probably the explanation for the fact that there is much less information about Soviet space research on television screens nowadays. The point is that when we reported at length and trimphantly about Soviet space programs in the past, this, as has now emerged, ultimately did not contribute to the success and glory of Soviet space research but, on the contrary, did it harm. People started asking whether all these manned space flights were necessary and how much money was being spent on them. [video shows trajectory chart] It also became obvious that the public at large was not very interested in the fundamental research conducted aboard the space stations, such as the creation of fundamentally new materials and pure proteins, because all this seemed to

be geared to the distant future, while people today want instant returns. This position prevails at the moment, and as a result appropriations for space research have been cut.

However, the event which was scheduled to take place today at the flight control center has attracted special attention. [video shows flight control center, followed by various aspects of the "Kristall" module] The new "Kristall" module was scheduled to dock with the "Mir" space station. It is a technological module. It carries furnaces, special installations for the production—semicommercial production—of crystals, pure proteins, and new drugs. What is more, these materials are not merely designed for scientific research in laboratories: They will also go to industry, thus providing industry with an instant return.

The last two steps remain to be taken in switching on the engines of the "Kristall" module to bring it close to the "Mir" space station. [video shows charts again] The first step was successful. The module began its approach to the station. But then the module's onboard computer analyzed the situation and cut short all approach operations. The module and the station began to draw apart. What happened? I talked to people in charge of the various systems involved in this work. [video shows correspondent talking to experts] They told me that there was nothing to be done but wait until the telemetric information has been decoded. In principle, there is enough fuel aboard the "Kristall" module for two more dockings, so that there is no emergency. Ballistics experts are saying that the most advantageous moment for docking will be 10 June. A docking on the 10th will mean lower fuel consumption—and fuel, as you know, is valuable in orbit.

To conclude my reportage I must tell you an amusing story. This morning some people called the "Mayak" radio station, saying that they were astrologers, and they predicted in the morning, before there was any news from orbit, that the "Kristall" module would not dock today, that there was little chance.

'Kristall' Orbit Adjusted, New Docking Attempt To Take Place 10 Jun

LD0706121290 Moscow International Service in Russian 1140 GMT 7 Jun 90

[TASS correspondent report from Flight Control Center]

[Text] Moscow 7 June (TASS)—An adjustment to the trajectory of the "Kristall" module aimed at establishing a new orbit which will ensure docking with the manned complex "Mir" on 10 June was conducted at 1204 hours Moscow time today [0804 GMT]. The adjustment was carried out using low-thrust back-up engines of the orientation system.

The parameters of the "Kristall" module's orbit are at present:

—Maximum distance from the Earth's surface: 419 kilometres;

—Minimum distance from the Earth's surface; 389 kilometres;

—Period of revolution: 92.5 minutes;

—Inclination: 51.6 degrees.

The crew of the "Mir" complex have a day off today.

Rendezvous Maneuver Executed 9 Jun

LD0906100390 Moscow TASS in English 0941 GMT 9 Jun 90

[By TASS special correspondent reporting from Mission Control Center]

[Text] Moscow June 9 TASS—Anatoliy Solovyov and Aleksandr Balandin continue their work on board the Mir orbital scientific and research complex. They have carried out another series of experiments to assess the influence of outer space on structural materials' physical and mechanical characteristics.

According to the medical control plan, the cosmonauts' cardiovascular system was thoroughly tested. They carried out the "Sport" experiment to determine optimal regimes for physical training in conditions of a long-term stay in weightlessness.

According to the Kristall module flight program, the module executed another rendezvouz maneuver at 10:34, Moscow time, today and is to dock with the Mir complex on June 10.

'Kristall' Docking Achieved 10 Jun

LD1006144890 Moscow TASS in English 1431 GMT 10 Jun 90

[by TASS correspondent Rena Kuznetsova]

[Text] Moscow June 10 TASS—The Kristall module docked with the manned complex Mir today. Two additional corrections of the module's trajectory of movement had been made on June 7 and 9.

Mutual search, rendezvous, tethering and docking were carried out automatically and were controlled by the Mission Control Center, as well as cosmonauts Anatoly Solovyov and Aleksandr Balandin.

The module blasted off from the Baykonur launch site on May 31. Originally, it was scheduled to dock up with Mir on June 6. But, the docking was put off because a computer had pinpointed a malfunction in one of the engines of the module's orientation system. The launch of the Kristall module had also been postponed several times.

The introduction of a third module to the Mir orbital complex will considerably expand the program of scientific and technological experiments.

The Kristall module has five installations to carry out experiments in material science and the production of high quality semiconductor materials and metallic alloys for contemporary microelectronics.

Biotechnical experiments also form an important part of the research program. They include experiments to attain crystals from biological substances and cell cultures and manufacture biologically active products with preset properties for use in medicine and other branches of the national economy, as well as experiments to develop a method of making new highly-effective medical preparations in conditions of weightlessness.

The module has the Glazar-2 ultra-violet telescope with onboard guidance, a complex [of] spectrometers to carry out astrophysical experiments and the Priroda-5 photo equipment for taking photos of the earth's surface.

Experiments on further cultivation of plants in conditions of a space flight will be carried out in the space greenhouse Svet produced in Bulgaria.

The total weight of the space system "Mir—Kvant—Kvant-2—Kristall—Soyuz TM-9" is 83 tonnes.

The Kristall module will be redocked to a new place on June 11.

Cosmonauts Solovyev, Balandin Complete 4 Months in Orbit

LD1106202190 Moscow TASS in English 1953 GMT 11 Jun 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow June 11 TASS—Today it is four months of the work in orbit by Soviet cosmonauts Anatoliy Solovev and Aleksandr Balandin. Following a check-up of the airtightness of the docking assembly, they opened transfer hatches and began to reactivate the specialised technological module Kristall.

In accordance with the program, the module today redocked from the axial docking port of the transfer compartment of the station to a lateral one. All this was done automatically by means of the module's manipulator. The operation was monitored by the Mission Control Center and the crew.

Following the lift-off, the module stayed in orbit for ten days before docking with the long-duration orbital complex Mir. The first attempt to dock with the complex, scheduled for June 6, failed.

Following the first engine ignition at the designated time, there was no second ignition owing to malfunction of one of the orientation system engines. In view of that, the docking was postponed until June 10. Instead of the malfunctioning engine, a stand-by set of engines was ignited and functioned properly.

Before their space expedition is over, the cosmonauts are hoping to launch space technology work on the equipment of the module which experts refer to as a "microfactory in orbit" for the production of high-purity semiconductor crystals.

According to preliminary estimates by scientists, a sufficient amount of high quality semiconductors may be produced on board the module within three years to pay back the expenditures on the development and launch of the module.

According to schedule, the crew are to begin producing semiconductor materials on the Krater installation on June 15.

Besides, the cosmonauts continue to implement an extensive program for nature study, medico-biological, astronomical, and astrophysical research and experiments.

'Kristall-Mir' Docking, Implications Reported

PM1206160390 Moscow Television Service in Russian 1700 GMT 10 Jun 90

[From the "Vremya" newscast: Reportage by S. Slipchenko, P. Orlov, Yu. Korovkin, identified by caption, on the docking of the Kristall module with the Mir space station]

[Text] [Newscaster] Today at 1447 hours Moscow time the new Kristall technological module docked with the Mir space station.

[Correspondent] To bring you up to date let me tell you that four days after the first unsuccessful attempt, specialists at the Mission Control Center realized which engine had failed, switched to the backup engine, and the docking today could not have gone more smoothly.

[Ya.Ye. Ayzenberg, director general of the "Elektropribor" scientific production association, identified by caption, facing camera] We have mastered the main and most important task. We have docked, that's it.

[Correspondent] [video shows people at work at Mission Control Center] Who will work with the module now? Will it be a group of specialists as in the past, or will representatives of plants, ministries, suppliers, and envoys of planning, agricultural, and other organizations begin to trickle into the Mission Control Center? Somehow we cannot visualize this, and here is why.

[Another correspondent] [video shows him interviewing three people watching docking at mission control center] Are there any doubts about the docking in orbit which we have just watched? Will it produce the return for which we are hoping?

[USSR Pilot-Cosmonaut V.V. Polyakov, deputy director of the Medical and Biological Problems Institute, identified by caption] Certain ministries, aware of the potential inherent in space, are deliberately keeping aloof, rather than coming forward with orders.

[Correspondent] Why?

[Polyakov] It seems to me that this is because it is not advantageous for them. It is even advantageous for them to stay away. After all, they would have to invest their own funds to obtain information, about the ecological situation, for instance, which they themselves are disrupting.

[USSR Pilot-Cosmonaut A.P. Aleksandrov, identified by caption] Agriculture, for example, has still not developed any systems which could be placed on board.

[USSR Pilot-Cosmonaut A.A. Leonov, in uniform, identified by caption] Or rather, they have developed them but they do not want to use them.

[Aleksandrov] Precisely.

[A.A. Leonov] Our data are objective, the data which we are able to obtain have differed from the USSR State Committee for Statistics information by as much as 30 percent.

[Correspondent] So who will use this most high-tech and valuable information in the world?

[Leonov] We are getting many orders from abroad, where people understand all this. But our comrades are still looking at all this askance.

[Correspondent] Soviet people are expecting and even demanding returns from space research. For a long time scientsts tried to persuade us that the entire 30 years of Soviet space research are just the base of the pyramid whose tip has now been attained with the Kristall module. Now the module is in orbit. It represents objective eyes which count arable land, herds of livestock, moisture and salt in the fields; it can produce pure medicines and grow crystals. However, at the same time it also shows up false statistics, it renders worthless hundreds of departmental documents and wipes out departmental jobs, if you like. This is where space research comes into conflict with sluggishness and inertia.

And what do those who developed the module and launched it into space expect from it?

[Yu.P. Semenov, rocket and space system chief designer, identified by caption] This is the beginning of far-reaching work in the sphere of technology and biotechnology.

[USSR Pilot Cosmonaut V.A. Solovyev, in charge of the mission, identified by caption] We expect a great deal. We would like it to start up industrial production, we would like it to start producing for the earth.

[A.V. Vasilkovskiy, deputy chief designer, identified by caption] The docking of this module alone expands the potential for building large-scale projects in space.

[Correspondent] This is what the Mir station may look like tomorrow. [video shows model of station] And the results of its work will depend less on the state of weightlessness in space, than on the degree of inertia on earth.

'Mir' Crew To Photograph Earth 19 June

LD1906171490 Moscow Domestic Service in Russian 1100 GMT 19 Jun 90

[Text] The Flight Control Center reports the space watch of Anatoliy Solovyev and Aleksandr Balandin on board the Mir complex continues. Today it is planned to take a series of photographs of southern areas of the country using Priroda-5 photographical complex and KAP-350 topographical camera within the framework of the program for the research of the earth's natural resources and the study of environment. The schedule also envisions a technical experiment to assess the strength characteristics of the structure of the Kvant-2 re-equipment module. Smelting continues on the Gallar unit, which is to last 120 hours. The aim of this technological process is to grow monocrystal of zinc oxide semiconducting material in the conditions of weightlessness. The results of medical monitoring show the state of the crew's health is good. The flight proceeds normally.

Mission Extended to 9 August

PM2206210590 Moscow TRUD in Russian 23 Jun 90 p 2

[Special correspondent V. Golovachev report: "Are the Cosmonauts in Danger?"]

[Text] Mission Control Center—"A Fault in the Soyuz Heat Insulation System Presents a Colossal Danger to the Soviet Space Crew"; "Will A. Solovyev and A. Balandin Be Able To Return to Earth?"—some time ago articles with those headlines appeared in foreign publications when it became known that almost half of the vacuum-shield heat insulation system (EVTI for short) had become detached from the body of the craft and large insulation elements, about 2 meters long, were waving about in space like leaves, fastened on one side only. The Mission Control Center directors announced at that time that there was no danger to the crew even though this unpleasant surprise created extra difficulties for the performance of the flight.

In order to maintain the required temperature within the reentry vehicle (and the temperature can fluctuate within rigid limits from plus 5 degrees C to plus 30), the station has to be rotated regularly, twice a day, throughout the flight first turning one side toward the sun, then the other. In addition, warm air is pumped from the station

into the reentry vehicle through a special air duct to prevent the buildup of moisture. The flight is going normally.

But won't the flapping "leaves" hinder the Soyuz landing? The most varied situations were studied in research and experiments on earth and in almost every instance reliable methods (including manual methods) were found to carry out the reentry program in full. However, there is a very small possibility of a development of events in which the "leaves" would become entangled and alter the movement of the reentry vehicle and the living compartment when they undock. In that case a collision between those compartments in space cannot be ruled out. I repeat, the likelihood of that is negligible but when dealing with space it cannot be ignored.

After heated discussions the decision that deputy flight director B.D. Blagov announced to journalists yesterday was finally made: The crew will have to go out in space and secure the EVTI. That will take time. And to carry out the program of work on board the station in the interests of the national economy and science the flight will be extended 10 days.

Thus the cosmonauts will have to return to earth not on 30 July, as planned, but on 9 August. The launch of a new crew to replace A. Solovyev and A. Balandin is now planned for 1 August.

Soyuz will have to redock to complete the repair. How will the "leaves" behave? Specialists are confident that there should be no complications. But in the event of an accident, the crew will break off their maneuvers around the station and returned to earth ahead of schedule. The redocking is set for mid-July.

'Mir' Cosmonauts Starting 20th Week of Flight

LD2406214190 Moscow Domestic Service in Russian 1800 GMT 24 Jun 90

[Text] The crew of the Mir orbital complex is starting its 20th working week. The cosmonauts will be engaged in experiments in geophysics and in the study of materials in space. According to the program of research of the earth's natural resources and study of the environment, it is planned to take photographs of various areas of the country. Optizon, a new technological apparatus, which is installed in the Kristall module, is beginning to function. The unit is designed for growing silicon monocrystals in conditions of weightlessness. According to the schedule for re-equipping the station with additonal installations, monitoring checks and preparations for forthcoming astro-physical research of the new (Buket) gamma-ray spectrometer, which is also installed in the Kristall module, are planned.

Officials Deny 'Disastrous' Situation on 'Mir'

LD2506212190 Moscow TASS in English 2115 GMT 25 Jun 90

[Text] Moscow June 26 TASS—Soviet space official denied a newspaper report on the return of cosmonauts Anatoliy Solovyov and Aleksandr Balandin had been delayed due to a "disastrous situation aboard the Mir space station."

The crew's return has been postponed from July 22 to August 1.

Mission control officials told Soviet television on Monday that reports about the destruction of Mir's heat insulation were "incompetent" in technical terms.

"It is foolish to dramatize the situation, since it is within what normally happens," officials said.

"There are several sheets—ripped off screens of vacuum and heat insulation. In order to determine what caused this and prevent this from happening in the future, one, maybe two, space walks will be needed," they said.

The crew were happy about the change in the program, and enthusiastically accepted "interesting work" that is "slightly different from life inside the station", they said.

Cosmonauts are used to completing things. They want to know what caused the problem.

17 July Space Walk Planned

LD2906103890 Moscow TASS in English 1013 GMT 29 Jun 90

[Text] Moscow June 29 TASS—The crew of the sixth main expedition of the Mir orbital complex is completing its 20th week in space.

Under the program for the study of the earth's natural resources and the environment with the use of photo equipment and spectrometers, the cosmonauts are taking pictures of various regions of the planet. The experiments aim to obtain scientific information on the state of flora and water reservoirs in different regions of the country, the bioproductivity of sea water and large-scale ocean currents.

A 160-hour experiment to grow a monocrystal of zinc oxide, a semiconducting material with improved characteristics, in the electric heating device "Krater-B", continues.

Today, the crew will conduct geophysical research and scheduled maintenance of on-board systems and equipment.

Anatoliy Solovyev and Aleksandr Balandin will spend part of the day preparing spacesuits and equipment for extravehicular activities. A spacewalk is scheduled for July 17.

Both cosmonauts are in good health.

Rescue Possibilities Cited

LD2906182190 Moscow Domestic Service in Russian 1500 GMT 29 Jun 90

[Text] Preparations are being completed in our country for a new manned space flight. In mid-July two crews will set out to the Baykonur cosmodrome. On 1 August one of them should be launched into space and replace Anatoliy Solovyev and Aleksandr Balandin on the Mir complex. The latter two have been working in space for half a year.

Our special correspondent, Leonid Lazarevich, asked Aleksey Arkhipovich Leonov, deputy head of the Cosmonaut Training Center, to talk about the concluding stage of this expedition.

[Begin recording] [Leonov] You know that on [July] 16-17 it is planned that cosmonauts Solovyev and Balandin will go out into open space. They are to go round to the descent vehicle, inspect it, carry out measurements of the thickness of the heat-protection covering, return the heat-protection covering to its initial state, check the cartridges and caps [piropatrony i kolpachki], and check that nothing has happened to them, and to transmit all the information to earth. On the basis of this information a decision will be made as to what we should do next.

[Lazarevich] In the Western media there has been much talk about the crew being deprived of the possibility of returning and that it will be necessary to send up a vessel; they have described the situation as tragic.

[Leonov] I do not know where this information has come from. The people who are responsible for this work have not given these reports to anyone. We have heard that indeed our heat protection covering has been torn off and is in a free state. It was torn off probably with the movement of the fairing. I am still amazed that this did not lead to pressure loss. And I was delighted at the courage of the crew who made an umbrella and that umbrella began to protect the station from the direct influence of the solar system. But this situation is somewhat easier. But all the same, we shall look at all of this with attention and if it is necessary to send a new vessel there then we have a well worked out program for this. We have a rescue vessel. We have cosmonauts and rescue commanders who are ready to go up at any moment, tomorrow if necessary, to render assistance. Apart from this rescue vessel a variant of the transport vessel could go up, dock automatically and pick them up. But at the moment we are not particularly worried although we are undertaking all necessary measures and working out various options. We have already worked all of that already.

[Lazarevich] Aleksey Arkhipovich, who are these rescue commanders who can go up to help at any moment?

[Leonov] Lyakhov, Tolya Berezovoy, Sasha Volkov, and Volodya Titov. Four of them, very experienced cosmonauts who have been on flights and whom we have been training for years without a flight engineer. [end recording]

[Announcer] The return to earth of Anatoliy Solovyev and Aleksandr Balandin is planned for 9 August.

Cosmonauts Redock Soyuz TM-9

LD0407085690 Moscow TASS in English 0807 GMT 4 Jul 90

[Text] Moscow July 4 TASS—TASS correspondent reports from Mission Control Center:

Soviet cosmonauts Anatoliy Solovyev and Aleksandr Balandin during their space flight earlier this week performed geophysical survey and space materials studies.

Using Priroda-5 photography complex and videospectrometric equipment installed on a platform of the Kvant-2 module, they photographed land and areas of the world ocean. The cosmonauts also conducted experiements to evaluate the ecological state of water basins in the southern Soviet Union. The technological process to grow a monocrystal of zinc oxide that was conducted for 160 hours in Krater-B unit has been completed.

Under the program of the flight of the Mir space station the crew today separated the Soyuz TM-9 transport ship from the astrophysical module Kvant and linked it to the station's docking section.

The spacecraft separated at 0208 Moscow time [2208 GMT 3 July]. The cosmonauts used manual controls to manoeuvre in orbit, flying around the space station, docking and link-up. The Soyuz TM- 9 spaceship was in autonomous flight for 26 minutes.

An eleven-day experiment to grow a monocrystal of a semiconductor will be started in the Krater-B plant in the evening.

The flight of the manned complex proceeds normally. The cosmonauts are in good health.

'Serious Problems' Aboard Soyuz TM-9 Reported

LD0607121490 Moscow in English to North America 2300 GMT 5 Jul 90

[Excerpts] Serious technical problems have developed aboard the Soyuz TM-9 transport aircraft which is part of the Mir complex now orbitting the earth. This naturally affected the work program of its crew, Anatoliy Solovyev and Aleksandr Balandin. Mission control has decided that the crew will have to perform an unscheduled walk in space to carry out the necessary repair work. So why has the flight program had to be changed so drastically? Here's our science correspondent Boris Belitskiy to answer that.

[Belitskiy] The Soyuz TM-9 transport is the craft in which the current crew are to return to earth. Any fault in it is, therefore, of the greatest concern to the mission control. In this case, the fault is unprecedented—the heat insulation of the craft is damaged.

[Announcer] How could this have happened?

[Belitskiy] The most likely explanation is that during the launch the spacecraft was badly scratched by the pylon of the emergency rescue system. This tore part of the craft's heat insulation, leaving a two-meter patch of it dangling from the craft.

[Announcer] But the damaged craft has now been in orbit for over four months.

[Belitskiy] Yes, and all this time steps have had to be taken to maintain a normal temperature inside the spacecraft deprived of its protective garment. Mission control solved this problem rather originally: Twice every 24 hours the orbital complex was turned so that the insulation would face the sun. As an additional precaution a pipeline was assembled to carry warm air from the living compartment of the orbital complex to the transport craft. However, maintaining the required temperature in the damaged craft isn't the only problem. The fact is that one of the suspended patches of the thermal insulation is obstructing the view of an infrared sensor which is linked to the attitude control system of the craft. This could cause departures from normal conditions during the landing of the craft. [passage omitted]

[Announcer] A walk in space has been planned, hasn't it?

[Belitskiy] Yes, as a matter of fact a new problem clinched the issue. There's a remote possibility that when the spacecraft undocks from the station, the dangling two-meter patch of thermal insulation could get snarled in the station's antenna system, called Kurs. This is very unlikely, but still, should it happen after the motors have been fired, the moving parts of the complex could collide. Not a pleasant prospect.

[Announcer] I think not. It seems far better for the crew to put aside their scheduled work for those repairs. But then they won't cope with their program will they?

[Belitskiy] Well, at first glance this doesn't seem to be tragic. The job will be completed by the next crew aboard the complex. But, on second thought this means another six-month wait for the long-expected products of that work; so to solve this problem, Mission Control recently proposed to the designer-general Yuriy Semenov that the mission be extended for the period of time that the repair work will take. This proposal has been adopted, and on Tuesday, 17 July the crew carrying the necessary tools are to step out of their orbital station into raw space for the job of repairing the damaged thermal insulation.

[Announcer] And how has this affected the schedule of their return to earth?

[Belitskiy] The next crew are now to be launched on 1 August, and the present crew are to return to earth on 9 August.

Cosmonauts Prepare for Space Walk

LD1007203290 Moscow TASS in English 1937 GMT 10 Jul 90

[Text] Moscow July 10 TASS—Operating under the flight program, Anatoliy Solovyev and Aleksandr Balandin continue preparations for a space walkout, the main task of which is to fix parts of the shield-vacuum heat insulation of the Soyuz TM-9 spaceship.

The cosmonauts will exit to the outside surface of the space complex through the airlock of the Kvant-2 module.

The airlock is used by the crew to store instruments and equipment and to check the operation of docking systems.

The two cosmonauts will undergo a checkup of their cardiovascular systems in the afternoon in compliance with a medical monitoring schedule.

A joint Soviet-Bulgarian experiment to study the development of higher plants in space conditions continues in the space greenhouse. The microclimate for the growth of garden radish and lettuce is automatically maintained in the greenhouse.

The cosmonauts monitor the operation of automatic systems, photograph the plant, and report the results of their observations to the flight center.

The mission of the crew is going on smoothly. The cosmonauts are healthy and feel well.

'Mir' Replacement Crew To Launch 1 Aug

LD1207172290 Moscow TASS in English 1607 GMT 12 Jul 90

[Text] Moscow July 12 TASS—A two-man crew is to be launched to the Soviet orbital station Mir on August 1, Lieutenant-General Vladimir Shatalov chief of the Yuriy Gagarin Cosmonaut Training Center near Moscow, told reporters at the centre today.

The crew, who have already completed their preflight training, include Commander Lieutenant-Colonel Gennadiy Manakov, 40, and Engineer Gennadiy Strekalov, 49.

This will be Manakov's first space flight. As a military pilot he has tested 40 types and modifications of aircraft. Manakov was a back-up for the commander of the outgoing Mir crew.

For veteran Strekalov this will be the fourth flight.

The back-up crew includes Commander Colonel Viktor Afanasyev, 41, and Engineer Musa Manarov, 39.

Like Manakov, Afanasyev tested about 40 types and modifications of aircraft, including MiG-29. Manarov already was on a year-long mission to Mir from December 1987 to December 1988. Later, he was elected deputy of the Russian Parliament.

The cosmonauts will have to carry out a large volume of observations and experiments. They also plan two spacewalks.

At the end of their expedition, next December, the cosmonauts plan to host a Soviet-Japanese crew.

After a week's rest, on July 19, the cosmonauts will leave for the Baykonur launching site.

Commentary on Cosmonaut EVA with New Manned Maneuvering Unit

907Q0047 Moscow PRAVDA in Russian 2 Feb 90 2nd ed p 1

[Article by A. Tarasov: "Get Into Your Sleighs!: A Report from the Flight Control Center"; first four paragraphs are from TASS, with a dateline of Flight Control Center, 1 February, and serve as the source introduction]

[Text] *In accordance with the flight plan, Aleksandr Viktorenko and Aleksandr Serebrov have performed their fourth EVA and were the first to carry out testing of a device which will enable cosmonauts to maneuver outside the manned complex.*

Today, Aleksandr Serebrov used the device in open space. Before going out, the cosmonauts put on their space suits, and the flight engineer took his position in the device and secured himself to it.

At 1115 Moscow time, the airlock hatch on the Kvant-2 module was opened, and the crew went outside. The testing was carried out in several stages. Using thrusters, Aleksandr Serebrov moved various distances from the orbital craft and carried out various maneuvers, rotations, and linear translations in various planes in space. The cosmonaut moved a maximum distance of 33 m from the exit hatch.

Upon completion of the scheduled testing, both cosmonauts returned to the airlock. The crew worked in open space for 4 hours 59 minutes.

The device merely looked easy to operate. Movement away from the station went more or less normally, as did the hovering, but the return was askew. The enormous "boot"—a nonsymmetrical complex of three bulky units and a pair of small craft—moved to the side. The exit hatch moved to the left, and the operator gave a corrective pulse, but the winch cable started him twisting and turned him so that his side was to the mooring, and then his back. And rocking like a pendulum, the operator trudged his way back to the module. I was gripped by fear as I watched from outside the whole thing: what a field of vision to have in that tiny spacesuit as you see, instead of the familiar mooring, the diagnoal grid of the solar panels and then just the stars themselves, feeling with your back the all-too-swift approach of the wall...

This was a training exercise. Even more than a training exercise. Simulation of all imaginable (and unimaginable) situations in preparation for the flight had been going on for a long time at the Cosmonaut Training Center, taking the vagaries of the spacecraft configuration and the capabilities of the "flying chair" into account. A unique creation of the scientist-designers and engineers at the Cosmonaut Training Center is an electronic simulator that uses a color screen and computer processing of the steering signals to recreate any sort of difficulty in flight. Aleksandr Shurubkin, an experienced test engineer and the director of the Zvezdnyy scientific research laboratory is in the black "horn" of the cabin, in the simulator chair. At the control and monitoring consoles are the developers, systems analysts, and cosmonauts. That includes Viktor Blagov and his crew from the Flight Control Center. Each maneuver, each turn, each simulated event is discussed. And of course, the most difficult operations imaginable are given, and Shurubkin emerges from the "horn" drenched in sweat, even without a spacesuit.

All this is done, of course, so as to not actually get into such a situation during the real thing.

And here it is, the real thing. The balcony at the Control Center is filled to overflowing. Everyone involuntarily gathers around Gai Ilich Severin, the general designer at the Zvezda factory—the birthplace of all space suits, aircraft ejection seats, and, finally, the orbiting "air-sleighs."

Yes, my coined term seems most appropriate to me. You sit as though on a sleigh; the runners are actually air-powered, 32 nozzles with two imposing tanks of compressed air.

Vityaz-1 (Aleksandr Viktorenko) is helping Vityaz-2 (Aleksandr Serebrov) strap himself into the flying chair. They're performing an extremely careful check of the spacesuits and a supercareful check of the spacesuit radio system.

The radio system had been tested the previous time on a tether, and there was no end of nervousness. This nervousness finally wound up in a joyful "Hurrah!" And for good reason—the permanent, head radio "tuner," Margarita Mintskovskaya, had set up a simulation of the failure of both miniature radio systems hidden in the tiny spacecraft/spacesuits. And everything went all right—everything was heard perfectly well on the ground and between the two cosmonauts. They had even switched from a serious tone to a joking one—it was a sign of complete confidence. But doing things with a tether is one thing, and the critical moment had arrived. Sasha Serebrov is unfastening the snap-hook and is detaching the winch clip from his "belly." And he's going off into free flight. In fact, it should be mentioned, this moment had been delayed because of the capriciousness

of a communications satellite. The conversation still had to be carried out through ground stations in an abbreviated session.

At first, the effect of the safety winch on the dynamics of the MMU—the manned maneuvering unit—is carefully tested. Then the cosmonaut moves a short distance away from the spacecraft and executes careful maneuvers 3-5 m from the mooring. The thrusters are switched on increasingly boldly and longer. A brief respite, and then a more decisive flight 20 meters from the craft. Finally, one last test: stopping after accelerating, and the brake on the safety winch operates reliably.

Is personal transportation really necessary in space, or is it routine imitation and a tribute to fashion? Imagine a cosmonaut in his awkward attire moving the length of the complex in small steps, reattaching the snap hook of the safety line every second, grasping a different handhold every meter, from which the overworked hands ache for days afterwards. The distance from one end of the complex to the other is already nearly fifty meters. Tomorrow, with the docked Buran shuttle (whose protective tiles need to be inspected) and the framework of Mir-2, where remote units need to be replaced or repaired, the complex will be hundreds of meters long. It would be ridiculous and naive to move tortoise-like there—what is needed is maneuverability and free flight.

So our guys quite properly took their places in their "sleighs", and they guided them confidently.

Austrian Cosmonaut Candidates Resume Training for 1991 Space Flight

LD1005164290 Moscow TASS in English 1623 GMT 10 May 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow May 10 TASS—Clemens Lothaller and Franz Viehboeck, candidates for a joint Soviet-Austrian flight to the Mir orbital station, have renewed training today at the Cosmonaut Training Center near Moscow, following a brief leave.

Lothaller and Viehboeck arrived at the star town early this year to prepare for the flight scheduled for 1991.

The Austrian pilots are now going through a general space training period, USSR Glavkosmos told TASS. The pilots are acquiring knowledge necessary for the next stage—the study of special disciplines directly associated with the space complex. They are also studying the Russian language and keeping in shape.

Immediately previous to the flight, one of the candidates will be named to participate in the eight-day expedition.

Soviet and Austrian scientists are preparing a scientific reserach program for the joint crew. The vast program will include remote sounding of Austria's territory and medico-biological experiments.

Commentary on 'Granat' Project

907Q0026 Moscow PRAVDA in Russian 3 Dec 89
Second Edition p 6

[Commentary by R. Syunyayev, science director for the Granat Project and corresponding member of the USSR Academy of Sciences: "X-Ray Stars"; callout reads "Granat: Our Commentary"; first paragraph is source introduction]

[Text] **The Granat spacecraft, placed into orbit on 1 December [1989], was developed in the Scientific Production Association imeni S.A. Lavochkin. It represents a continuation of the series of well-known Venera craft, which were also used in the development of the Vega craft. The Astron satellite, developed on the basis of this same series of spacecraft, has been in orbit for six years. Granat is the last satellite of this series. The craft in this series have been continually improved, and it is pleasant to note that, on Granat, science equipment already makes up more than half of the mass of the craft placed into orbit. It is a payload of almost 2,300 kilograms.**

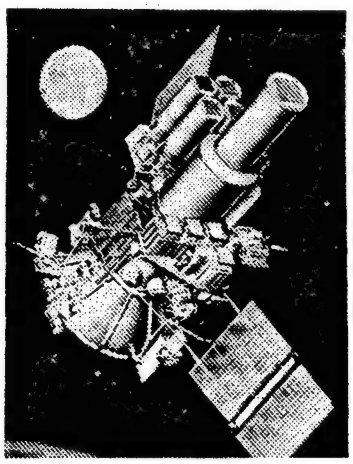
Twenty years ago, with the launching of the first specialized American satellite, a new field of science—experimental high-energy astrophysics—emerged. It made it possible to study the matter within gravitational fields and near black holes and neutron stars; sources with an enormous density of radiant energy inaccessible to ground lasers; and relativistic plasma with temperatures in the billions of degrees.

Granat is the first specialized x-ray and gamma-ray satellite produced by us as a great space power, and, at the same time, it is an international observatory. We have lost an awful lot of time and now we are looking into the future with hope. The Proton rocket made it possible to insert the satellite into a remarkable elliptical orbit with an orbital period of 4 days and a distance of 200,000 kilometers from the earth. As a result, the processes associated with the capture of cosmic rays by the earth's magnetic field will not affect instrument readings.

One of those instrument—Sigma, which was developed by France's Nuclear Center in Saclay and the Space Center in Toulouse—weighs a whole ton. It enables operation at the junction of the x-ray and gamma-ray bands, construction of images of selected sectors of the celestial sphere, and location of radiation sources. Scientists from all over the world would like very much to use this device to find the spot where there is an astonishing source which radiates in the line of annihilation of the electron and its antiparticle—the positron. The nature of this source is unknown, and, to this day, no one has been able to identify it with any of the objects known to science.

The observatory's scientific instrument package includes the ART-P and ART-S astronomical x-ray telescopes. The four ART-P telescopes, developed by the USSR Academy of Sciences' Space Research Institute and the Institute's Special Design Bureau in Frunze, are capable of constructing x-ray images.

Granat is also carrying the largest set of gamma ray-burst instruments. Its basic component is the Konus device, which was developed at the Leningrad Physical Technical Institute of the USSR Academy of Sciences under the supervision of Professor Ye. P. Mazets. The French instrument "Febus", which is sensitive to very hard gamma rays, makes it possible to extend the range of Konus into the region of higher energies.



Granat is outfitted with a steerable platform which makes it possible in 1.5 seconds after the arrival of a gamma-ray burst to turn the x-ray detectors, as well as an optical monitor, to the direction from which the burst came. This system has been given the name "Podsolnukh" [Sunflower]. We would add to what has been said that the counters in this system use an electronic analysis unit which was developed jointly by Bulgarian and Soviet specialists and was built in Bulgaria. Detectors from the Danish Space Research Institute have also been installed, and they make it possible to track across the entire sky, seek, and locate sources which flare up from time to time in the x-ray sky. This is a new task for us.

In connection with the launching of Granat, it is pleasant to note the path which Soviet scientists and our colleagues from the FRG, Holland, Great Britain, and the European Space Agency have traversed thanks to the international Rentgen observatory on the Kvant module. It has been operating for more than two and a half years now. The main result has been the discovery of the hard x-ray radiation of the supernova. This radiation owes its origin to the radioactive decay of elements produced during the "death" of the star and during its transformation into a neutron star or a black hole.

This discovery is all the more important because the last supernova which was visible to the naked eye exploded in our firmament in the year 1604, and there has not

been such a phenomenon for nearly 400 years now. It is wonderful that, at the needed moment, our country and our colleagues in scientific cooperation had on board the Kvant module, which was docked with the Mir space station, an observatory with instruments which were precisely the best ones for detecting the supernova's specific hard radiation.

Now Granat is being brought in to patrol for the supernova's x-ray and gamma-ray radiation along with Kvant. Its observations will make it possible to understand the physical conditions within a dying star, in an area where intense nuclear combustion has occurred. This is extraordinarily important for modern nuclear astrophysics.

The question arises, What are the advantages and the drawbacks of a specialized satellite, as compared with the instruments on an orbital observatory? It must be noted right off that, despite the acknowledged success of the Rentgen observatory, the multipurpose Mir station was able to provide us with only 2,200 observation sessions over two and a half years, for a total duration of 2 million seconds in all. The Granat observatory should operate continuously three days out of four.

It is necessary to note that Granat and Kvant are by no means alone in orbit. For almost three years now, the small Japanese Ginga satellite, equipped with instruments manufactured in England and the USA, has been operating successfully and producing extremely interesting results. In June of the coming year [1990], the gigantic American gamma-ray observatory is supposed to be launched. Its instruments are capable of solving some of the problems for which Granat is also intended. We await this launching because it is much more interesting to work together. For example, many of Kvant's observations have taken place simultaneously with those of Japan's Ginga, and this has produced much more interesting results than if each side had conducted them separately.

The field of experimental high-energy astrophysics is continuing to develop. The tone for the high quality of the work of the Soviet specialists here was set by our theoretical astrophysicists. Therefore, in conclusion, I would like to express my gratitude to my teacher, Academician Ya. B. Zeldovich, who stood at the cradle of the Granat project.

Radioastron Project Probably To Be Delayed Two Years

907Q0046A Moscow NTR TRIBUNA in Russian
No 1-2, Jan 1990 p 3

[Article by N. Layevich: "Time Trouble For 'Radioastron'"]

[Text] Sadly, the list of fields in science and technology in which the Soviet Union is ahead of the rest of the world continues to shrink. Space exploration has always occupied a special place among those few fields which remain. However, even here the position has changed for the worse in recent years. The failure of both Phobos spacecraft, the "moratorium" on manned spaceflight, the long delay on the Buran shuttle... We never like to see this list increase in size, but the Radioastron international project may now end up on this list as well.

This became clear at the regular conference on the Radioastron project recently held in Tashkent. The technical director of the program, V.Andreyanov, says there is very little hope that launch will occur as scheduled in late 1993. It has become clear that our typical red tape, which turns one-month projects into six-month projects, will delay the launch by a minimum of two years.

Recall that this is a unique landmark project in the history of world radio astronomy and has served as a framework scientists from 13countries to design and construct a very-long-baseline interferometer (VLBI). This will be the first antenna system to have an equivalent size nearly equal to that of the Moon's orbit... The first, that is, if the Radioastron project wins the race against time with its American and Japanese competitors. And work on these spacraft is moving full steam ahead.

However, rather than this issue, the paper read by the scientific director for the project, N. S. Kardashev (Corresponding Member, USSR Academy of Sciences), addressed a proposed new orbit for the satellite (much higher than the old orbit at both apogee and perigee) which will reduce the interference from the Earth during VLBI operations and increase the number of observable radio sources, especially in the Southern Hemisphere.

Such a wonderful idea would ordinarily be welcomed. However, the traditional conflict in space science between those who set the scientific goals and those who develop the spacecraft (and who have quite modest capabilities for implementing the scientific goals) comes into play here. If the spacecraft is placed in an even slightly higher orbit above the Earth, the weak transmitter signal will simply be unable to reach the tracking stations on the ground.

The conference participants produced a fairly loose compromise: To operate in the old orbit for the first two years, and then transfer the spacecraft to the new orbit only after it has completed its planned program... This doesn't seem to solve the problem that had come up, especially since it will still be necessary to add more VLBI equipment, even in this case.

Which is less important? Being first in a new field of space research-space-based radio astronomy-or the time available for research and various scientific projects... The scientists themselves will decide, but to me the second variant seems preferable. Especially since there is one item which has, in my view, largely been ignored in the scientific program: Geodetic and astrometric research. In the words of the head of the working group for these fields, I. Fejes, the results of more ambitious

research in these fields might be able to completely pay for some of the costs of the project, which would be quite welcome in these times.

The better is the enemy of the good. It would undoubtedly be better to obtain results of some kind by carrying out the project than, in Andreyanov's words, "to divide up the skin of a bear that hasn't been killed yet (or, for that matter, even born yet)," by adding complications to a project which is already behind schedule.

'Gamma' Observatory Spacecraft Launched

LD1107144790 Moscow TASS International Service in Russian 1315 GMT 11 Jul 90

[Text] Moscow, 11 July. (TASS)—In accordance with the program of space research, the "Gamma" unmanned observatory, designated for carrying out research in the field of the astrophysics of high energies, was launched in the Soviet Union by means of a "Soyuz" carrier rocket at 1400 hours Moscow time today.

The observatory's basic instrument, the "Gamma-1" telescope, enables a search to be conducted for gamma radiation sources in a broad range of energies and permits their position in the firmament to be determined with a high degree of accuracy. The observatory's research apparatus also includes "Disk" and "Pulsar X-2" which measure the X-ray and soft gamma radiation. The "Telezvezda" star sensor ensures accurate survey of sources of gamma-quanta. The scientific data is processed by a "Spektr-2" onboard computer.

The scientific equipment of the observatory—mass 1,700 kg.—was developed and manufactured by scientific and industrial organisations of the USSR, France, and Poland.

The "Gamma" space observatory has been put into earth satellite orbit with the following parameters:

-initial period of revolution, 88.45 mins;
-apogee, 233 km;
-perigee, 190 km;
-orbital inclination, 51.6 deg.

The gamma observatory's onboard systems are working normally.

The Flight Control Center is receiving and processing the incoming information.

Details of 'Gamma' Equipment Provided

LD1207084590 Moscow TASS in English 0750 GMT 12 Jul 90

[Text] Mission Control Centre July 12 TASS—The Gamma astrophysical laboratory was launched by a Soviet booster rocket from the Baykonur launching site on Wednesday.

The project is being carried out by the Soviet Institute of Space Research, the Moscow Engineering and Physical Institute, the Soviet Academy of Sciences' Ioffe Physical and Technical Institute, and the Energiya Scientific and Production Amalgamation, the French National Space Research Center, the Center for Space Radiation Studies, and the Astrophysical Service of the Nuclear Research Center, the Polish Academy of Sciences Space Research Center, and the Warsaw Polytechnical Institute.

The project had been delayed and the launch postponed. When an operator on duty announced that the new astrophysical observatory was in orbit, ending the first stage of the project, those present at the Mission Control Center heaved a sigh of relief.

"Compared to similar instruments used before, our Gamma telescope has more characteristics and better sensitivity to register space gamma-radiation and resolution power," Professor Galper, a manager of the Gamma project, told TASS.

"The second telescope, Disk-M, is intended to study low-energy gamma-radiation. One more telescope at the observatory, the Pulsar X-2 X-ray telescope, is on the outside of the laboratory and is connected to the Spectrum-2 board mini-computer, designed by French specialists."

All telescopes have been installed with their axes parallel. The Telezvezda star sensor, developed by Polish engineers, will help position them.

The complex of instruments at the new space observatory will help conduct research in a wide range of the electromagnetic spectrum. Scientific equipment installed at the observatory wieghs some two tons.

Priority astrophysical research objects have been determined. A pulsar in the Sails constellation will be used to calibrate the scientific equipment.

Research will explore the Large Magellanic Cloud where a supernova appeared in the beginning of 1987. Researchers are planning to observe several other objects outside the galactic plane.

It will take four days to make an orbit, a month to test board systems, and a fortnight to calibrate instruments. Specialists believe Gamma will be ready for standard work by September 1.

UDC 520.87:535.317.25

Effect of Increasing Telescope Resolution Caused by Turbulent Atmospheric Inhomogeneities

907Q0029 Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 11, Nov 89 (Manuscript received 04 May 89) pp 1050-1056

[Article by V. Y. Zavorotnyy, M. I. Charnotskiy, Institute of Atmospheric Physics, USSR Academy of Sciences, Moscow]

[Abstract] Under certain conditions, turbulence in the atmosphere actually increases the resolution of a telescope above the diffraction limit. A confirmation of this is the phenomenon in which stars flicker, but planets do not when viewed at the same zenith angle. A similar phenomenon is studied which utilizes a more detailed description of the image—the spatial spectrum of the image formed by the telescope. In plane 1 is a noncoherently illuminated object, at a distance L from which, in plane 2, is the receiving aperture of the telescope; at distance z from the object, in plane 3, the image of the object is recorded. The space between planes 1 and 2 is partially or fully filled with a turbulent medium. The authors find that, under certain conditions, some components of the image frequency may correspond to object frequency components beyond the limits of telescope resolution. References 6: 5 Russian, 1 Western.

UDC 523.53

Heights of Radio Meteors and Fine Meteor Particle Breakup in the Atmosphere

907Q0030A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 23 No 4, Oct-Dec 89 (Manuscript received 21 Nov 87) pp 282-288

[Article by B. L. Kashcheyev, V. N. Lebedinets, V. N. Oleynikov, Kharkov Institute of Radio Electronics; Tayfun Scientific-Production Association]

[Abstract] The MARS apparatus and a supplementary meteor radar operating at 5.23 m were used to measure the heights, velocity and amplitude-time characteristics of signals reflected by radio meteors. The biomodal distribution of altitudes of slow radio meteors points to the multicomponent composition of the complex of small meteor bodies and to the discrete distribution of their characteristics. Approximately half of the slow radio meteors were generated as dense stone meteor bodies which do not break up, whereas the other half were carbonaceous chondrites and other bodies which break up in the atmosphere. The observed height distribution is well explained considering this multicomponent composition and the influence of the initial radius of the ionized meteor tracks on radio echo amplitude. Figure 1; References 11: 8 Russian, 3 Western.

UDC 523.5

Study of Television Spectrograms of Meteors

907Q0030B Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 23 No 4, Oct-Dec 89 (Manuscript received 07 Jul 87; after revision 02 Nov 87) pp 297-303

[Article by S. Mukhamednazarov, N. V. Maltseva, Physical-Technical Institute, Tadzhik Academy of Sciences]

[Abstract] Preliminary processing is undertaken of television spectrograms of meteors—measurement and identification of the wavelengths of spectral lines, as well as determination and analysis of their relative intensities. Studies are performed on three sporadic meteors observed by means of a television system. The radiation of the basic rock-forming elements FeI, NaI, MgI and CaI is observed in the spectra of the weak meteors. The atmospheric lines and bands of OI, NI and N_2 make up most of the radiation. The ratios of the major elements remain constant along the meteor tracks. Figures 2; References 9: 5 Russian, 4 Western.

UDC 523.3+523.8

Estimate of Dynamic Parameters of Moon Based on Laser Measurements

907Q0030C Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 23 No 4, Oct-Dec 89 (Manuscript received 29 Jan 87) pp 304-312

[Article by S. G. Valeyev, M. A. Fursenko, V. N. Boyko, Ulyanovsk Polytechnical Institute; Institute of Theoretical Astronomy, USSR Academy of Sciences]

[Abstract] An approach is utilized for regression modeling of a two-year series of laser observations of a corner reflector on the moon in which, in addition to estimating the parameters, a search is made for the set of unknowns which best corresponds to the specific series of observations. This procedure is called structural identification of the model, since it attempts to identify the structure of the model which is adequate to the real set of observations with all of their singularities. The results of the modeling and of the analysis of the models suggested by regression modeling and singular expansion confirm the need to use the regression modeling approach for processing data of laser observation of the moon. References 16: 9 Russian, 7 Western.

UDC 524.7-7

Analysis of 'Mean Spectral Index-Flux Density' Relationship for Extended Components of Extragalactic Radio Sources

907QOO37A Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 66 No 6, Nov-Dec 89 (manuscript received 14 Dec 88) pp 1121-1131

[Article by K. P. Sokolov, Radioastronomical Institute, Ukrainian Academy of Sciences]

[Abstract] A preliminary evaluation was made of the possibility of detection of statistically significant changes in the mean values of key spectral indices for samples of radio sources of different intensity. It is shown that the preliminary numerical evaluation of the anticipated interval of change of the investigated spectral indices for extended radio sources is in good agreement with the observed changes in the distributions of low-frequency (ν_1 = 25, ν_2 = 178 MHz) spectral indices in samples of sources of different intensity. An analysis was made of the possible physical factors, which for the most part, determine the existence of the "spectral index-flux density" experimental relationships in different frequency ranges. The astrophysical significance of these relationships and their possible applications are examined. It is

shown that the observed increase in the spectral indices for extended radio sources, with a decrease in their flux densities, is consistent with the assumption of the existence of a correlation between the values of the low-frequency spectral indices of these sources and their red shifts. Figure 1; references 51: 6 Russian, 45 Western.

UDC 524.7

Research on Radio Objects With Continuous Optical Spectra. Search for Spectral Details Using 6-m Telescope

907QOO37B Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 66 No 6, Nov-Dec 89 (manuscript received 30 Jan 89) pp 1132-1141

[Article by V. A. Lipovetskiy, L. A. Pustilnik, S. A. Pustilnik and A. I. Shapovalova, Special Astrophysical Observatory, USSR Academy of Sciences]

[Abstract] The results of spectral observations of 13 radio objects with continuous optical spectra (ROCOSs) made with a 6-m telescope using a 1000-channel photon counter are presented. In the spectra of 9 bright ROCOSs with flat radio spectra, there were neither narrow details with a contrast relative to the continuum level nor broad lines. The collected data are consistent with the hypothesis that ROCOSs are objects of the BL Lac type with luminosities in the MgII 2798 line which do not exceed or are comparable to those for known lacertids. For four faint ROCOSs (m = 18.5-19) having steep radio spectra up to the centimeter range there was reliable registry of broad emission lines with contrasts of 0.2-0.3. Red shifts, equivalent widths and half-widths of the lines were determined, and the absolute star magnitudes of the objects and line luminosities were estimated. Two of these objects can be classified as radio quasars, whereas two others are classified as objects intermediate between blazars and ordinary radio quasars. Figures 4; references 27: 11 Russian, 16 Western.

UDC 520.822

Narrow-Band Photometry of Halley's Comet, λ = 3820 A

907QOO37C Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 66 No 6, Nov-Dec 89 (manuscript received 7 Sep 88) pp 1283-1288

[Article by B. Komitov, V. Shkodrov, V. Ivanova and S. Stoyanova, Base Observatory, Space Research Institute, Stara Zagora, Bulgaria; Astronomy Section, Bulgarian Academy of Sciences, Sofia; National Astronomical Observatory, Stara Zagora]

[Abstract] Five photographs of Halley's comet were obtained using a narrow-band filter at 3640-4000 A with the 70-cm telescope of the Bulgarian National Observatory during the period 25 April-14 May 1986. The photographs were used in studying the mechanisms of production and emission of cyanogen at λ = 3883 A in Halley's comet. The CN molecule in Halley's comet is a daughter product of the photodissociation of a more complex molecule. The brightness profile indicates that the main mechanism for the excitation of λ = 3883 A is resonance fluorescence and CH_3CN, C_2H_5CN and C_2N_2 cannot be among the main parent molecules. The parameter of coma extent of the parent molecules was determined for a heliocentric distance R = 1.75 a.u. A comparison of this result with the rate of radial movement of HCN, obtained from radio observations, indicates that HCN is not the predominant parent molecule of cyanogen, although its contribution may be considerable. Figures 4; references 14: 1 Russian, 13 Western.

UDC 524.35

Indication of 62-Hour Periodicity in Sco X-1 Determined From X-Ray Experiment on Prognoz-9 Artificial Earth Satellite

907Q0038A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 12, Dec 89 (manuscript received 1 Jun 89) pp 1072-1080

[Article by M. I. Kudryavtsev, N. A. Mamontova, S. I. Svertilov and Ye. D. Tolstaya, Nuclear Physics Scientific Research Institute, Moscow State University]

[Abstract] In the course of an X-radiation experiment on the Prognoz-9 satellite over a period of about 100 days there were virtually continuous observations (each averaged 10 s) in the vicinity of the center of the galaxy. A scintillation spectrometer with an effective area about 40 cm^2 was used. A 62-hour periodic process was revealed as a result of analysis of the dependencies of the counting rate in the energy range 10-50 keV determined during the period 31 October-20 December 1983 by the technique of superposition of epochs. Despite the fact that the X-radiation instrument had a rather broad field of view, about 0.7 sr, it was possible to carry out an experiment for determining the angular coordinates, which, in turn, made it possible to delimit the region of probable localization of the source of this periodic process. It was found that a single known galactic source, Sco X-1, an object differing in many respects from other galactic objects and for which no generally accepted model exists, is situated in the investigated region. Figures 3; references 19: 4 Russian, 15 Western.

UDC 520.87:535.317.25

Experimental Detection of Supradiffraction Resolution of Telescope in Observation of Objects Through Turbulent Medium

907Q0038B Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 12, Dec 89 (manuscript received 13 Jun 89) pp 1131-1134

[Article by V. U. Zavorotnyy, V. A. Myakinin and M. I. Charnotskiy, Atmospheric Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] The authors earlier demonstrated that under certain conditions a turbulent medium may result in an increase in the resolution of a telescope above the diffraction limit. The objective of this continued research is experimental confirmation of this effect in the laboratory. The experimental apparatus was quite simple (observed object, model of turbulent layer, collecting lens, image recording device). The object used was an amplitude transparency, a square target with 8-mm sides. The target interval was 0.48 mm. The transparency was illuminated by a system consisting of a light source and condenser. A water-filled cell of optical glass 25 cm long and 20 cm wide in which convective turbulence was generated by heat exchangers served as the layer of turbulent medium. The target image observed through the cell was formed by the collecting lens. The distance between the target and lens was 3 m; the focal length of the objective was 30 cm. The image was recorded by a television camera and fed to a display, which was photographed. Four such photographs are illustrated and discussed. They confirm the theoretically predicted effect of telescope resolution above the diffraction limit when making observations through a turbulent medium. Figure 1; references 3 (Russian).

UDC 629.87

An Analytical Method for Determining Elements of Keplerian Orbits From Two Spacecraft Positions

907Q0039A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 3 Jun 88) pp 803-807

[Article by N. L. Sokolov and A. P. Sokolov]

[Abstract] Various methods for determining orbits in the two-body problem are known, but these methods involve application of iteration procedures. An approximate analytical method is proposed for computing the values of orbital elements using finite formulas. This reduces the duration of computations by a factor of about 5-8. The research revealed the use of the proposed method for computing the elements of Keplerian orbits with a small eccentricity with angular distances between radius-vectors not exceeding 90° to be highly effective. The method also can be used for determining the elements of high elliptical orbits when the spacecraft flight time between two fixed positions is not greater than 4-8 minutes. The errors in determining orbital parameters do not exceed 5%. Figures 2; references 9: 5 Russian, 4 Western.

UDC 629.197.2

Geometrical Solution of Rendezvous Problem in Near, Almost Circular Coplanar Orbits

907Q0039B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 16 Dec 88) pp 808-816

[Article by A. A. Baranov]

[Abstract] Two-, three- and four-impulse maneuvers ensuring a soft rendezvous of an active spacecraft with a target spacecraft are examined. In published studies there are no simple algorithms which could be used in solving a specific problem when the initial and final orbits and maneuvering intervals are stipulated but the maneuver parameters must be determined. This article gives iteration procedures which make it possible to determine the parameters of transfers during a fixed time, the energetics of which coincides with the minimal energetics of transfers between these same orbits under the condition that the transfer time is not fixed. The problem is solved in a linear formulation within the framework of unperturbed Keplerian motion. It is assumed that the impulses are imparted in two maneuvering segments (no more than two impulses in each), separated by several revolutions. Algorithms are written which make it possible to determine the angles of application and components of the impulses for which the total characteristic velocity of the maneuver is minimal. Figures 8; references 7: 6 Russian, 1 Western.

UDC 629.015

Research on Evolution of Almost Circular Orbits of Distant Artificial Earth Satellites Near Resonance 3/1 With Moon Using Numerical-Analytical Method

907Q0039C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 2 Nov 88) pp 817-826

[Article by M. A. Vashkovyak]

[Abstract] The principal features of evolution of nearly circular orbits of an artificial earth satellite (AES) with a period of revolution equal to 9.1 days are examined. Such orbits, with a radius about 184,000 kilometers and an eccentricity about 0.1, are subjected to the strong, perturbing influence of the Moon. This circumstance, as well as the resonance character of the perturbations, especially of the semimajor axis of the AES orbit and its longitudes, afford a possibibilty for more precise determination of lunar mass. A numerical-analytical method is described which takes the resonance character of satellite motion into account. The dependencies of the elements of a number of orbits on time are determined, and estimates are made of the change in eccentricity and inclination in a five-year interval. The numerical-analytical computations give quantitative results which are in satisfactory agreement with the results of numerical integration of the rigorous equations of motion of artificial earth satellites. Figures 4; references 8: 5 Russian, 3 Western.

UDC 550.338,517.983.54

Regularization Method for Finding Distribution Function of Wave Vectors of Low-Frequency Electromagnetic Radiations Observed in Near-Earth Plasma

907Q0039D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 12 Jul 88) pp 877-882

[Article by V. S. Arefyev, L. B. Volkomirskaya, S. A. Gorbunov and A. Ye. Reznikov]

[Abstract] A new method is proposed for finding the distribution function for wave vectors of low-frequency

radiations observed on artificial earth satellites on the basis of data from multicomponent measurements of the electromagnetic field. It is compared with the currently used maximum entropy method (F. Lefeuvre, et al., ANN. TELECOM., Vol 34, No 1, p 204, 1979, who also furnished the initial data for the study) and is shown to have a number of advantages over the Lefeuvre method. These include absence of loss of part of the information and a lesser relative nonclosure of the solution obtained, which is evidence of a more precise retrieval of the distribution function. The simplicity and economy of the developed algorithm make possible its application using small computers and on-board processors. Figures 2; references 7: 4 Russian, 3 Western.

UDC 551.510.536

Temporal Change in Parameters of Disturbed Region Created in Atmosphere by Pulsed Source of Ultraviolet Radiation

907Q0039E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 16 Dec 88) pp 883-889

[Article by N. V. Yeliseyev, V. A. Kiselev and S. I. Kozlov]

[Abstract] The initial chemical composition of the disturbed region created in the upper atmosphere by a pulsed source of ultraviolet radiation, with allowance for the contribution of the forming photoelectrons, was examined in earlier publications (Yu. M. Grishin, et al., KOSMICH. ISSLED., Vol 26, No 4, p 614; Vol 26, No 6, p 868, 1988). This article examines the relaxation of the parameters of the disturbed region to the background level. It was found that at altitudes 100-140 km, a decrease in the concentrations of disturbed components is attributable for the most part to the occurrence of chemical reactions and spontaneous radiation. The spatial-temporal distributions of the parameters and the intensities of the emissions stimulated by the effect of a pulse of ultraviolet radiation are examined. The disturbance source examined here can be used for physical simulation of a number of phenomena arising in the atmosphere and ionosphere under the influence of other sources of artificial origin. Figures 3; references 18: 9 Russian, 9 Western.

UDC 550.385.41

Diffuse Auroral Zone. X. Diffuse Auroral Zone, Oval of Discrete Auroral Forms and Diffuse Glow Poleward of Oval in Nighttime Sector as Projections of Plasma Domains in Magnetotail

907Q0039F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 14 Mar 89) pp 890-901

[Article by Yu. I. Galperin and Ya. I. Feldshteyn]

[Abstract] Active discussion continues concerning the projection of the nighttime sector of the oval of discrete auroral forms under stationary conditions onto the plasma domains of the magnetotail. It is widely held that the oval is projected by magnetic lines onto the boundary region of the plasma sheet (BPS). The authors of this article, like some other researchers, feel that the near-midnight part of the oval under stationary conditions is projected onto the main (central) part of the plasma sheet (CPS), depending on the activity level between 5-10 and 30-50R_E. On the basis of the totality of various experimental data, including those from satellite measurements under the ARCAD program, it is shown that the zone of diffuse auroral glow, situated equatorward of the oval of discrete forms and from the sharp boundary of capture of energetic particles, is projected onto the inner magnetosphere between the inner boundary of the plasma sheet and the boundary of large-scale convection; the oval of discrete auroral forms is projected onto the main central or low-latitude plasma sheet region; the band of diffuse auroral glow poleward of the polar arc of the auroral oval (narrow at the time of disturbances, but strongly expanding during quiet intervals) is projected onto the boundary region of the plasma sheet. Figures 6; references 47: 6 Russian, 41 Western.

UDC 551.521.8

Prediction of Electron Fluxes and Spectra in Earth's Radiation Belts

907Q0039G Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 22 Jun 88) pp 902-906

[Article by Yu. V. Mineyev, I. N. Senchuro, P. I. Shavrin and Ye. S. Vinogradova]

[Abstract] At the present time the long-range prediction of fluxes of relativistic electrons in the Earth's radiation belts in the energy range 0.3-7 MeV is accomplished using computation models for periods of both maximum and minimum solar activity. However, certain experimental data relating to features in the spectra of electrons, dependencies of the electron fluxes on geomagnetic activity, D_{st} variations and solar wind velocity are not reflected in the computation models. On the basis of these data it is possible to supplement models and predict electron fluxes at time scales of about two weeks. The detected features in the differential energy spectra of electrons have been observed during the last two solar activity cycles. These features have a stable character and must be taken into account in computation models. Variations in the fluxes of relativistic electrons in the outer radiation belt are determined primarily by magnetic storm intensity, not by the solar activity cycle. The determined dependencies of the electron fluxes, including the maximum fluxes, on the magnitude of variations and solar wind velocity, must be used in a short-range prediction of radiation safety. Figures 4; references 17: 12 Russian, 5 Western.

UDC 537.591.574.83

Lags in Hard X-Radiation of Solar Flares According to Data From Sneg-2M3 Instruments

907Q0039H Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 17 Mar 89) pp 907-917

[Article by S. V. Bogovalov, Yu. D. Kotov, V. M. Zenchenko and Viktoriya Kurt]

[Abstract] The energy dependence of the lags in hard X-radiation of solar flares arising in a model of the capture of accelerated particles in a magnetic trap was investigated. An algorithm for the statistical analysis of the lags is proposed. Eighty flares registered in the Sneg-2M3 experiment were analyzed. In virtually all the considered 80 impulsive flares, the relative lags of hard X-radiation in the range 50-300 keV were less than the time resolution 0.5 s. Longer lags must be expected in gradual flares, for which the capture model is most probably realized. When using the described retrieval method, models of the acceleration of particles and their propagation in the solar atmosphere require spectral measurements with a time resolution better than 0.1 s for impulsive flares and about 1 s for gradual flares (the duration of impulsive flares is usually less than 1 minute, whereas for gradual flares it is tens of minutes). Statistically reliable lags were discovered during a flare on 12 November 1981. However, the nature of the lags could not be determined in it because of large errors. In another flare, on 15 December 1982, the temporal variation contradicts predictions of the capture model. The maximum of acceleration of electrons with an energy over 150 keV in this flare is attained 10 s after the maximum of acceleration of electrons with an energy about 50 keV. A possible explanation of this deviation is proposed. A number of limitations superposed by lags on the flare model are discussed. Figures 4; references 20: 2 Russian, 18 Western.

UDC 581.521

Dynamics of High-Energy Electrons During International Magnetosphere Research Interval 22 March 1979 According to Data From Intercosmos-19 and Cosmos-900 Artificial Earth Satellites

907Q0039I Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 18 Nov 88) pp 946-949

[Article by I. B. Volkov, A. V. Dronov, L. M. Kovrygina, Yu. V. Mineyev, E. N. Sosnovets and L. V. Tverskaya]

[Abstract] The literature already contains several articles concerning phenomena in the magnetosphere associated with two substorms of 22 March 1979 (CDAW-6 interval). This article, for this same interval, examines data from simultaneous measurements of electrons in the energy range 0.04-2 MeV at low altitudes on the Intercosmos-19 and Cosmos-900 artificial earth satellites. The discussed data considerably supplement the picture of development of magnetospheric disturbances during this period obtained using data from high-apogee satellites and surface data. It was possible to clarify the effects exerted on the distribution and behavior of electrons of different energies by individual successive substorms in the course of a world magnetic storm. It was found, for example, that the acceleration of electrons with energies up to 0.1 MeV in the inner regions of the magnetosphere (up to L equals approx. 2) already occurs in the preparatory phase of a substorm during intensification of the DP-2 current system. Latitude variations of auroral regions of electron leakage also were investigated. Figures 2; references 11: 7 Russian, 4 Western.

UDC 520.6;524.722;524.352

X-Radiation Observations of Large Magellanic Cloud With TTM Telescope on Kvant Module in November 1988-June 1989

907Q0049A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 16 No 2, Feb 90 (manuscript received 28 October 89) pp 124-135

[Article by R. Syunyayev, M. Gilfanov, Ye. Churazov, V. Loznikov, N. Yamburenko, G. K. Skinner, T. G. Patterson, A. P. Willmore, O. Emam, A. C. Brinkman, J. Heise, J. J. M. In't Zand and R. Jager, Space Research Institute, USSR Academy of Sciences, Moscow; Space Research Laboratory, Utrecht, Netherlands; Birmingham University, Great Britain]

[Abstract] The results of observations of the Large Magellanic Cloud in the range 2-27 keV using the TTM telescope in the Kvant module during the period October 1988-June 1989 are presented. About 130 observation sessions involving the LMC were made during this period, with the Rentgen telescopes aimed at SN 1987A. The data made it possible to set an upper limit on the flux from the supernova 1987A, which was 0.6 mCrab in this energy range (these observations correspond to the period from 630 to 840 days after the explosion of the supernova, a period when the hard X-ray flux from the supernova had conspicuously fallen). These data are compared with other observations. The results of observations of the sources LMC X-1, LMC X-2, LMC X-3, LMC X-4 and PSR 0540-693 are also given. Figures 5; references 12: 3 Russian, 9 Western.

UDC 520.6;524.354

New X-Ray Transient Burster KS 1731-260

907Q0049B Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 16 No 2, Feb 90 (manuscript received 28 Oct 89) pp 136-143

[Article by R. Syunyayev, M. Gilfanov, Ye. Churazov, V. Loznikov, N. Yamburenko, G. K. Skinner, T. G. Patterson, A. P. Willmore, O. Emam, A. C. Brinkman, J. Heise,

J. J. M. In't Zand and R. Jager; Space Research Laboratory, USSR Academy of Sciences, Moscow; Space Research Laboratory, Utrecht, Netherlands; Birmingham University, Great Britain]

[Abstract] The new X-ray transient burster Kvant Source (KS) 1731-260 was discovered during observations of a sector of the sky containing the known X-ray pulsar GX 1 + 4 on 16 August 1989 with the TTM telescope in the Kvant module of the Mir space station. The newly discovered source is situated at an angular distance of about 1° from GX 1 + 4 and 3°.8 from the center of the galaxy. The flux from the source in a quiet state in the range 2-27 keV varied from 50 to 100 mCrab. During the observation period from 16 to 31 August 1989 there were several bursts of X-radiation from this source with a duration of 10-20 s and a flux at the peak up to 0.6 Crab. The frequency of bursts from this source may be 13 per day, but the number may be as great as 30 per day. Figures 5; references 2 (Western).

UDC 523.4

Models of Internal Structure of Neptune With Period of Rotation Determined Using Voyager 2 Data

907Q0049C Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 16 No 2, Feb 90 (manuscript received 21 Sep 89) pp 174-177

[Article by T. V. Gudkova and V. N. Zharkov, Earth Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Previously, the period of rotation of Neptune was considered to have been reliably established on the basis of surface observations of details in the equatorial region. However, observations by Voyager 2 resulted in a new determination of the period of rotation related to rotation of the magnetic field, presumably characterizing rotation of its deep layers. The new period was substantially less: 16 hours 3 minutes +/-4 minutes. This fact, in particular, is evidence that Neptune, like Saturn, has appreciable differential rotation. Computation of a new model with the new period of rotation was undertaken (with the earlier period of rotation there were appreciable differences in the chemical composition of the outer shells of Neptune and Uranus). The new models which were constructed indicate that the internal structure of Neptune is similar to the internal structure of Uranus. This is a very important conclusion of great significance. The principal parameters of two- and three-layer models of Neptune are given in two tables. A comparison of the models of the internal structure of Uranus and Neptune suggests that the two may be twin planets. References 2: 1 Russian, 1 Western.

UDC 621.391.1:520.3

Method for Determining Coordinates of Television Images of Stars and Its Efficiency

907Q0050A Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 5 No 6, Nov-Dec 89 (manuscript received 18 Feb 88, after revision 29 May 89) pp 13-17

[Article by V. F. Krylkov, I. V. Shagulin, A. A. Shatalov and A. B. Yastrebkov, Leningrad Institute of Aviation Instrument Making]

[Abstract] In addition to detecting star signals, it is necessary to ascertain their precise coordinates. It is desirable that the coordinates of the center of gravity of the optical star image be used for this purpose. As a result of the use of image converters in television astronomy, the light (signal) incident on solid-state charge-coupling devices, because of the quantization of the images, made it necessary to develop a practical algorithm for evaluating the coordinates of the center of gravity and determining its qualitative characteristics. The proposed algorithm for determining star coordinates from the center of gravity of the potential image relief on the charge-coupled device, described and analyzed in detail, makes it possible to measure the position of stars with an accuracy dependent on the size of the image, the signal-to-noise ratio and the form of signal fluctuations. A formula is derived for determining the rms error in evaluating the position of stars. The algorithm accuracy can be improved by averaging the evaluations made using different image frames. Figure 1; references 4: 3 Russian, 1 Western.

UDC 524.6-77:520.27

Catalogue of Radio Sources With Improved Coordinates From Deep Survey

907QOO64A Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 67 No 1, Jan-Feb 90 (manuscript received 22 May 89) pp 1-9

[Article by V. R. Amirkhanyan, A. G. Gorshkov and V. K. Konnikova, State Astronomical Institute imeni P. K. Shternberg]

[Abstract] The RATAN-600 radio telescope was used during July- August 1987 for more precise determinations of declinations of radio sources in the Z8D Zelenchuk Deep Survey. Observations were made with the western sector of the radio telescope in an azimuth 270°. The observations were made at a frequency 3900 MHz in a scanning mode employing diagram modulation with a scanning angle 5'. The width of the directional diagram in azimuth and angle of elevation was 1.1 and 22' respectively; system response with a time constant 1 s and a reception band 600 MHz was 0.012 K. A final list (four-page table) of radio sources whose flux is greater than 40 mJy was prepared. The first and second columns give the coordinates of the sources for the epoch 1950;

the third and fourth columns give the flux and threshold of detection in an azimuth 270°; the fifth column gives the flux of the radio source in the Z8D catalogue. The rms error of declinations of sources stronger than 40 mJy was reduced to 7-15". Figures 4; references 10: 9 Russian, 1 Western.

UDC 521.13

Stability of Libration Points in Restricted Three-Body Problem With Variable Masses

907QOO64B Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 67 No 1, Jan-Feb 90 (manuscript received 3 Jul 89) pp 167-172

[Article by L. G. Lukyanov, State Astronomical Institute imeni P. K. Shternberg]

[Abstract] Studies by Orlov, Gelfgat and Bekov, as well as earlier work by the author, dealt with the existence of linear, triangular and coplanar special solutions in the restricted three-body problem with variable masses, but the question of the stability of these solutions remained open. Even for systems with constant and periodic coefficients the solution of the problem of stability (as defined by Lyapunov) involves great difficulties, which are still greater for investigations of stability of systems with variable coefficients. However, in the considered case it is shown that solution of this problem presents no difficulties due to the possibility of reducing the system of differential equations to an autonomous form. Computations are presented which make it possible to postulate that the motions of the primaries are determined by the Gylden-Meshchersiy problem and a change in their mass conforms to the unified Meshcherskiy law. It is demonstrated that all the libration points in this problem (linear, triangular and coplanar) for any parameters are stable relative to coordinates introduced by the Meshcherskiy transform. References: 8 Russian.

UDC 520.34

Four-Channel Star Electrophotometer for Measuring Bright Stars

907QOO64C Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 67 No 1, Jan-Feb 90 (manuscript received 10 Jan 89) pp 173-181

[Article by V. G. Kornilov and A. V. Krylov, State Astronomical Institute imeni P. K. Shternberg]

[Abstract] A four-channel electrophotometer was developed for measuring bright stars in the WBVR photometric system. The main feature of this instrument is that the separation of the light flux between four measuring channels is accomplished using translucent aluminum layers, which are relatively simple to fabricate. Despite the seeming lack of promise of such a solution, the efficiency of this photometer in measuring stars to $9\text{-}10^{m}$ in a telescope with a diameter 0.5 m is greater than for an electrophotometer with successive changing of light filters. The photometer has a number of additional advantages. An optical and structural diagram of the photometer with 11 components identified, as well as a circuit diagram, are used as a basis for a detailed description of instrument operation. During 1985-1988 it was used by the Tien Shan Expedition in obtaining highly precise WBVR magnitudes of about 15 000 stars. Recommendations are given on further improvement of the instrument. Figures 4; references 13: 4 Russian, 9 Western.

UDC 551.510.536

Structure and Properties of Earth's Plasmasphere. Experimental Data and Problems in Their Interpretation (Survey)

907Q0065A Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 30 No 1, Jan-Feb 90 (manuscript received 19 Jan 89) pp 1-17

[Article by K. I. Gringauz and V. S. Bassolo, Space Research Institute, USSR Academy of Sciences]

[Abstract] More than ten years have elapsed since publication of the last survey of research on the Earth's plasmasphere in the Russian literature. The most important results of direct measurements of plasma concentration and temperature and latest data on the mass charge composition of plasmasphere ions are discussed. These data confirm the existence of two zones in the plasmasphere: inner (L less than 3), which is stable, quasistationary and cold (T_i less than 0.8 eV); and outer, usually warm (T_i more than 1 eV), essentially nonstationary, with high longitudinal gradients of parameters. The boundary of the outer zone, the plasmapause, is clearly expressed in the evening-nighttime hours and is usually blurred in the daytime sector; it has a complex nonstationary structure, changes greatly as a function of geomagnetic conditions and has an asymmetry in local time. Evening and midday projections of the plasmapause onto the equatorial plane are well expressed. The conclusion is drawn from a comparison of these and other data with theoretical concepts that at present there is no generally accepted model adequately describing all the principal features of the observed structure and dynamics of the plasmapause. Figures 7; references 56: 8 Russian, 48 Western.

UDC 533.932

Role of Superthermal Electrons in Formation of Luminous Regions in Vicinity of Cosmic Body

907Q0065B Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 30 No 1, Jan-Feb 90 (manuscript received 6 Feb 89) pp 161-163

[Article by A. Yu. Olkhovatov]

[Abstract] A number of problems related to the formation of large regions of luminescence around a cosmic body are examined. Data from meteor observations are

compared with the results of rocket sounding of the atmosphere. It is shown that this phenomenon is attributable to the heating of ambient electrons with subsequent excitation of atmospheric components by electron impact. In the neighborhood of the body, conditions may prevail in which small disturbances result in heating of ambient electrons and ionization of atmospheric components. These phenomena take place most intensively at the altitudes of the ionospheric E and D layers. The maximal electrification of a space vehicle coincides with the altitude of the sporadic E layer or the irregular C layer. These facts strongly suggest that the mechanism of the phenomenon of anomalous heating of electrons and ionization of the ambient medium is related to the mechanism of formation of sporadic ionospheric layers. The disturbing factors may be electromagnetic waves or disturbances associated with motion of the cosmic body. An increase in the velocity of motion results in an increase in the level of medium excitation. References 12: 5 Russian, 7 Western.

UDC 681.3:523.164

Preliminary Data on Nature of Planetary System of Lineaments Observed on Radar Images of Venus (Data From Venera-15 and Venera-16 Spacecraft)

907Q0041 Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 23 May 88) pp 918-931

[Article by Ye. N. Slyuta, L. V. Kudrin and V. P. Sinilo]

[Abstract] The rather dense planetary system of spiraling lineaments observed on radar images of the Venusian northern hemisphere, whose nature remains unclear (it is uncertain whether the system is of natural origin or an instrumental effect), is described in detail. The system of lineaments was analyzed on a combined image of the surveyed territory formed from individual image bands. On the basis of a detailed analysis of the method for obtaining the image, it was possible to postulate possible mechanisms for the formation of the lineament noise component, whose study indicated that they do not explain the totality of features in the observed structure of the system of lineaments. The experimental data also show absence of similar defects in the data processing algorithms. With this taken into account, as well as data from a geological-geomorphological analysis of the system of lineaments as a whole and its individual components, it is postulated that this system is real, i.e., of natural origin. A rotational mechanism of formation of the described phenomenon, dating back to a time when the planet rotated considerably more slowly, is proposed. Some of the geological corollaries of the phenomenon are examined. Figures 7; references 18: 14 Russian, 4 Western.

Results From Plant Growth Experiments Aboard Orbital Stations

907Q0013 Moscow PRAVDA in Russian
22 Oct 89 2nd ed, p 3

[Article by A. Volkov, S. Krikalev, USSR pilot-cosmonauts, and G. Nechitaylo, UkSSR State Prize winner: "From Seed to Garden"; first paragraph is source introduction]

[Text] *A new space watch has begun on the Mir complex. Again, the first concerns of the new crew—Aleksander Viktorenko and Aleksander Serebrov—are about the delicate, sensitive biological objects that on the spacecraft are colorfully called "the garden." However, this garden is complicated and diverse, and its "beds" are skillfully made mechanical contrivances called upon to recreate for the plants conditions similar to those on earth and to compensate for the "strangeness" of weightlessness.*

In view of our comrades' concerns in space right now, we would like to talk about one of the areas of space research—biology. After all, it is that very area that is directly linked to further human advances into the universe.

After the completion of the fourth manned mission, biological equipment was returned to earth from Mir: pulleys, boxes, holders, linings. And everywhere, plants and more plants. This valuable living material, which was literally passed from hand to hand among biologists at the spacecraft landing site, was immediately processed and delivered to various laboratories in the country for delicate research on its biochemistry and ultrastructure. Today, there are already some results we can talk about.

Let's start with basic research.

There are three main reasons for the interest in plant development during space flight. First, there was the opinion that in weightlessness, living organisms, particularly plants, might experience disturbances in growth processes. Second, it has been discovered that plants have a physiological-biochemical mechanism controlling their spatial orientation in response to the force of gravity. The question arose as to whether that mechanism could be bypassed. Finally, research on the full development cycle is needed in order to find plants that can be included in the life-support system, which is crucial at this juncture in connection with plans for the development of deep space and, possibly, for the manned flights to Mars.

Flax, crepis (hawk's beard) and kale were the first plants grown in space. It was shown in principle that in the presence of light, water and mineral nutrients plants develop, orient themselves towards light and form roots, stems and leaves. However, their growth depends upon the development of the germ on earth. Some changes were noted at the cellular level, but they did not hinder plant development through the individual phases, including those right up to seed formation. It was those first, most definitive stages of plant growth and development that were studied on a whole array on installations: Svetoblok-M, Vazon, containers for Oazis-1M, and Fiton. Peas, wheat and arabidopsis were the research subjects. Above all, there was interest in processes involving the diffusion of cellular calcium in the roots. Studies of this material provided data on changes in aging processes in plants during space flight. Why is this question so important?

For more than 15 years now, doctors and biologists have been split on the extreme conditions in space flight. When, in fact, a human stays in space for a year and feels excellent, while some plants there undergo changes, it's either due to the conditions or to improperly set-up experiments. Is this all there is to it? Attempts have been made to identify the mechanism of changes, but thus far nobody has succeeded, although American and Chinese scientists have conducted numerous studies on the most diverse seeds. The advantage of our research is that we are the only ones who have been able to perform such long-term exposure of plant material as, for example, 811 days on the Salyut-7 and Mir space stations.

It has been established that seed hardiness—or as biologists say, their germinative and growth energy—depends upon the duration of space flight. As flight length increases, that resistance declines severalfold by comparison with control plants on earth. To remove the unfavorable factor of preliminary aging, the plants are processed with special antimutagens of plant origin several years prior to being sent into space. Such work is being done by specialists at the Genetics and Selection Institute, AzSSR Academy of Sciences.

It is already clear that the biological experiments not only are of fundamental theoretical significance, but also have obvious practical value. While V. Dzhanibekov and V. Savinykh were on the Salyut-7 station, cotton was grown on an artificial substrate in a small unit. The experiment failed several times. "It was painful to watch as the young leaves of the tender shoots curled up and the plants died," said V. Dzhanibekov. However, not long before returning to earth the plants suddenly sent up new shoots. These were raised in hothouses on earth, yielding a harvest of one seed that produced long-fibered plants. Today, there are already third-generation plants and more than 500 seeds retaining the long-fibered trait. Those results are inspiring great hopes.

In order to obtain new characteristics, a package has been sent to Mir with various plant seeds, including cotton, which will be exposed for various periods of time—from six months to three years.

Weightlessness is one of the unique factors of space flight. However, it is not so easy to utilize it in its pure form. There are several techniques in which weightlessness can have a noticeable effect. It has been suggested that some chemical reactions accompanying phase transitions take place differently under the conditions that

scientists now call mircogravity. Scientists at the Bioorganic Chemistry Institute, UzSSR Academy of Sciences, have begun to study those processes.

In the specially constructed apparatus Svetoblok-T, experiments have been conducted in weightlessness to obtain new polymer materials like polyacrylamide gel. That is a material used on Earth for electrophoresis—the production of ultrapure protein substances. The space-produced gel can produce samples four times as pure as those made on earth, and it has a more uniform structure.

When V. Dzhanibekov and V. Savinykh were working on Salyut-y, special regimes for synthesizing polyacrylamide gel were developed. As a result of the experiments that were conducted, it became obvious that the next installation had to have a damping device to eliminate the effect of movements loads that result in the spacecraft from crew activities.

During the fourth expedition on the Mir station, the 100th experiment was completed on the new unit. Twelve holders full of gel, each weighing one-half kilogram, were returned to Earth. An economic assessment of the effectiveness of that material is now under way. But we can already say that it is many times greater than the costs and it will enable the production of gels of a quality that cannot yet be achieved on Earth. That is one of the paths for biotechnology.

The next step in its development is the creation of a device for 200-300 kilograms. In the meantime, the crew on the Mir will be sent samples of a new series of gel for the development of various production regimes.

Experiments with animal and plant tissue cultures were continued on the last two missions on Mir. Basic biological processes here can also be of practical interest. If tissue cultures of arabidopsis were used as a model for studying cellular viability features and fine biochemical processes, tissue cultures of ginseng were used to increase biological activity in the samples in spacecraft by a factor of three, as compared with the control samples. After all, plant tissue cultures can be used as a supplement to cosmonauts' diet. That very fact was confirmed by V. Dzhanibekov and V. Savinykh during their difficult mission aboard Salyut-7. After mixing the ginseng tissue culture with honey, they took it upon themselves to eat a tablespoon of this mixture daily. They are confident that this "medicine" helped improve their efficiency. New antimutagens of plant origin were tested on Chinese hamster tissue culture. We will not name this preparation now, but we can confidently say that it reduced considerably the growth of cell tumors. A new crew is continuing this experiment, because plant and animal tissue cultures are excellent models for solving theoretical and applied problems in space flight.

Finally, traditional orchids were sent up with A. Viktorenko and A. Serebrova. They are not simply decorative plants, but are also long-term dwellers in space. They grow and develop in excellent fashion; but they do not blossom. After completion of the fourth mission, the plants were sent undamaged to the UkSSR Academy of Sciences Botanical Garden. Now the hardiest of them are being returned to orbit.

The biological program is not limited to this. In the near future a greenhouse for plants and an incubator for quail will begin operation in the modules. There are proposals from several foreign countries. All the same, in space biology we are considerably ahead of other countries, and it would be unbecoming to lose that lead. Moreover, we now need glasnost in programs and a wide circle of specialists to participate, on a competitive basis, in setting up and performing those programs.

UDC 629.7

Spatial Gyrodyne Systems

907Q0040A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 30 Jan 89) pp 827-835

[Article by Ye. N. Tokar]

[Abstract] This article represents a continuation of a series of 10 articles by the author and his associates on gyrodyne systems. Solutions are given for the problems involved in constructing spatial systems of gyrodynes which were formulated in a recent article by the author (KOSMICH. ISSLED., Vol 27, No 3, p 368, 1989). The conditions under which the required solution can be obtained with virtual assurance are outlined. The sought-for bodies are four of five regular polyhedrons, as well as some Archimedes bodies (semiregular polyhedrons). The solutions are given in detail. Various simplifications are proposed, as well as ways to facilitate and improve the solutions. It is demonstrated that series of polyhedrons, being solutions of the considered problems, are characterized by great diversity of configuration. Figures 7; references 10 (Russian).

UDC 629.7

One Mechanism for Loss of Stability of Satellite Gravity-Gradient Attitude-Control Mode

907Q0040B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 26 Sep 88) pp 836-848

[Article by V. V. Sazonov]

[Abstract] In an earlier article (V. A. Sarychev, et al., KOSMICH. ISSLED., Vol 26, No 3, pp 390-405, 1988), on the basis of statistical processing of telemetry information, a study was made of the motion of the Salyut-7 orbital station relative to the center of mass for prolonged time intervals. Several days after onset of uncontrollable motion with a low initial angular velocity, the station was held in a specific gravity-gradient attitude-control mode. In this mode, the service bay was turned toward the Earth, and its longitudinal axis made slow oscillations relative to the local vertical. The frequency of the oscillations in the orbital plane was roughly 1.54 ω_0, where $\omega_0 = 0.00114\ s^{-1}$ is the angular velocity of the orbital motion; the frequency of oscillations in the plane formed by the normal to the orbital plane and the local vertical was roughly 1.84 ω_0. The amplitude of both modes of oscillation was about 35-40° within a week after the onset of the uncontrollable motion. Such a spontaneous steady-state gravity-gradient attitude-control mode is evidently attributable to two factors: the destabilizing influence of atmospheric drag and the damping properties of station equipment. A further study was made of the loss of stability of the gravity-gradient attitude-control mode resulting in the appearance of such significant oscillations of the longitudinal axis. The analysis was made within the framework of the theory of bifurcation of generation of a limiting cycle. The existence of such oscillations, as validated in greater depth in this analysis, is caused by the balance between the dissipation of energy by on-board apparatus and the pumping of energy caused by the nonpotential nature of the aerodynamic moment acting on the satellite. Figures 7; references 11: 10 Russian, 1 Western.

UDC 629.7

Influence of Hysteresis Rod Mounted Along Axis of Maximal Moment of Inertia of Satellite on Its Motion in Gravity-Gradient Attitude-Control Mode

907Q0040C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 5 Oct 88) pp 849-860

[Article by V. A. Sarychev, V. I. Penkov, M. Yu. Ovchinnikov and A. D. German]

[Abstract] A study was made of the three-dimensional oscillations of a satellite with three identical, mutually orthogonal hysteresis rods, one of which is oriented along the Ox_2 axis of the maximal moment of inertia. Conditions are produced in which, when satisfied, small-scale satellite oscillations in the roll and yaw channels attenuate in a finite time. A rod situated along the Ox_2 axis exerts no influence (in the considered linear v approximation) on the pitching motion of the satellite. Because of this the results published earlier by the same authors (KOSMICH. ISSLED., Vol 26, No 5, p 654, 1988) can be applied for optimizing (with respect to speed) the damping of pitch oscillations (rods situated in the plane Ox_1x_3 must form an angle $\pi/4$ with the main axes Ox_1 and Ox_3. One of the rods mounted along the axis of the maximal moment of inertia of the satellite ensures the attenuation of the spatial motions in conformity to the Coulomb friction law. Approximate dependencies of the amplitudes of small oscillations on time in the form of finite relations are obtained with the approximation of the hysteresis loop by a parallelogram. Conclusions based on an analysis of the averaged system of equations of motion are consistent with the results of numerical integration of the initial nonlinear system with the use of the improved model of hysteresis dependence. Oscillations with an arbitrary amplitude are investigated numerically. Figures 5; references 6 (Russian).

UDC 629.195.1

Optimal Program for Control of Angular Position of Spacecraft With Flat Solar Panels

907Q0040D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 29 Jun 88) pp 861-866

[Article by A. M. Yanshin and S. M. Zabluda]

[Abstract] The problem of finding the stationary position of a spacecraft ensuring a minimal value of the kinetic

moment from external gravitational and magnetic disturbances and with maximal illumination of its solar panels was examined earlier (A. M. Yanshin, KOSMICH. ISSLED., Vol 24, No 1, pp 23-29, 1987). Proceeding on the basis of this earlier research, this article, which is essentially a continuation of the earlier work, examines the more general problem of finding such a program for control of the rotation of a spacecraft and the solar panels which ensures the maximal illumination of the panels and the minimal value of the gravitational moment. Specifically, the optimal angles of setting of a solar panel ensuring maximal integral illumination of the solar panels with restrictions on the channels for control of the solar cells are found for the case of passive gravitational stabilization of a spacecraft. The angles of rotation of solar panels ensuring maximal radiation controlling moments acting on the spacecraft are determined. Figures 3; references 3 (Russian).

UDC 629.125

Method for Plotting the Boundaries of the Region of Allowable Initial Positions of a Space Vehicle During Its Descent From Orbit in Planetary Atmospheres

907Q0040E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 21 Apr 88) pp 867-876

[Article by G. A. Vinogradova and S. A. Voyevodin]

[Abstract] One of the problems of flight to planets with atmospheres involves guiding the descent module from an artificial planetary satellite orbit to a stipulated sector of its surface using only aerodynamic forces. This is possible only in a case when the point of vehicle descent from orbit corresponds to definite regions of initial coordinate values characterizing the maneuvering capabilities of the descent module (without thrust) under specific flight control laws. For each vehicle, these characteristics are restricted to some limiting region, the so-called region of possible descent. The problem of search for a region limited by a set of initial points of optimal trajectories for descent into a planetary atmosphere is examined. Using this set of points it is possible to guide the descent module into a stipulated region under both normal flight conditions and in the presence of perturbing factors. The possible types of such a region are analyzed. A general method for defining such a region is outlined. An example of computation of such a region using quasioptimal control is given. Figures 5; references: 4 Russian, 1 Western.

UDC 629

Choice of Orbital Parameters of Artificial Earth Satellite With Maximal Observation Time of Stipulated Point on Earth's Surface

907Q0040F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 6, Nov-Dec 89 (manuscript received 7 Jun 88) pp 943-945

[Article by D. V. Serebryakov]

[Abstract] The following inverse problem is solved: finding the point N with the geocentric coordinates η, ξ for which its observation time from a satellite during motion in a stipulated orbit during one revolution is maximal. An illustrative example includes a table of pertinent parameters for quasisynchronous orbits ensuring optimal observation of a point with the latitude $\eta = 60°$. Numerical comparison of orbits with optimal parameters and orbits whose trajectory passes through a stipulated point in the latitude range 30-60° shows that the gain in observation time, virtually nondependent on the angular geocentric radius of scanning, varies from 2-4% to 8-20%. With an increase in orbital altitude, the angular velocities of rotation of the satellite and Earth become comparable, the trajectory becomes increasingly deformed and therefore the relative gain in observation time increases. For low altitudes—less than 1000 km—the gain in observation time is insignificant. Figure 1; references 5: 4 Russian, 1 Western.

Docking Unit on 'Kristall' Module Could Receive U.S. Shuttle

LD2006095190 Moscow TASS in English 0942 GMT 20 Jun 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow June 20 TASS—Soviet scientists and designers have developed a new unified docking system that could be used to dock the Soviet Mir orbital station with a U.S. space shuttle, Soviet cosmonaut Valeriy Kubasov told TASS.

In 1975, Kubasov participated in the Soviet-U.S. Soyuz-Apollo space programme. "The scientific aim of the joint flight was to test the rescue system for Soviet and U.S. spacecraft," he said.

"We tried to resolve the problem of docking spacecraft of various countries with different designs and technological systems. Soviet and U.S. specialists then developed the first unified docking device," Kubasov said.

Today, space is an area of international cooperation and security is a prime problem, Kubasov said. In the 15 years of Soviet-U.S. cooperation, the Soviet Union has accumulated experience of docking spacecraft in orbit and the new docking system proves this, he said.

The new system considerably exceeds its 1975 predecessor's characteristics. It is lighter and smaller than the system used to dock Soyuz with Apollo. The new system is installed on the Kristall technological module which joined the Mir orbital complex on June 10.

'Mir-2' Station Described

LD2005022190 Moscow in English to Great Britain and Ireland 1900 GMT 19 May 90

[Text] The new generation of the Soviet orbiting stations Mir will be manned by crews of between three and 12. That has been announced by a Soviet spacecraft

designer, Vladimir Pallo. Mir-2, which is now being designed, will be slightly bigger than the Mir station currently in orbit. It will allow the crew to perform a variety of operations from assembling large objects in outer space to experiments in geology and astrophysics. Technologies mastered by Soviet cosmonauts will be used to build semiconductors and other valuable substances on board.

Satellite Systems for Global Ecological Monitoring

907Q0059 Moscow IZVESTIYA in Russian
3 Jan 90 p 3

[Article by B. Konovalov, scientific reviewer, IZVESTIYA. First paragraph is introductory paragraph in source.]

[Text] We live in an abruptly changing world. And not everything is changing for the better. With each year the condition of the atmosphere, rivers, lakes, seas, and forests worsens, and the soil is exhausted. Due to the overpopulation of many regions the consequences of elemental disaster become more tragic. Now an urgent issue is the need to track all these processes on a global scale and the need to take timely measures, by national efforts or by all of human society. Only space equipment, with its efficiency and capability for global information collection can insure the resolution of this problem. Unfortunately, up until now there has been no international, efficiently constructed, orbital ecological patrol. We discussed what this might be with the director of work to create Soviet meteorological and natural resource satellites, the general constructor, Academician N. N. Sheremetyevskiy.

Q: Nikolay Nikolayevich, is there now the technical capability to create a global ecological patrol from space?

A: In principle, yes. A number of the developed nations, primarily the USA and USSR, have been rather intensely pursuing the creation of space systems in the interests of hydrometeorology since the early sixties, and they have pursued the study of Earth's natural resources since the seventies.

In the mid-eighties, France, Japan, and India created and placed in orbit their first spacecraft to study Earth's natural resources. The Canadian government decided to create in 1994 their own satellite system to observe the land and sea. Thus, there already are, or are planned, no less than seven types of space systems for ecological purposes, not counting military and manned space systems.

In the late eighties, many nations began creating the next generations of spacecraft to solve virtually homogeneous problems of ecological monitoring. The work is being done without any coordination, and common sense shows that this simply leads to unthinking expenditures of funds. A new way of thinking which is taking hold on our planet prompts the international community to join forces in tracking our common home, planet Earth, and creating a world-wide ecological system.

It is obvious that this process will be gradual. In the first stage, without encroaching on the tendencies of the narrow national development of existing systems, one could suggest the mutual coordination of launches of spacecraft, agreement on orbital parameters in order to obtain global portraits of our planet without gaps. In the future it will be sensible to eliminate excess duplication in the development of information equipment.

The Soviet prospective two-tiered system will use a new generation of spacecraft, which should be put into use in 1992-1993. The system is intended to solve ecological (hydrometeorological and natural resource) problems. The spacecraft themselves, with various complements of instruments, have already begun flight testing. The base satellites for low orbits will be Meteor 3 and Resurs 0. The heart of the system will be a meteorological spacecraft in a high geostationary orbit. Its launch is planned for 1991. In contrast to spacecraft of this type which have already been created by other countries, this one will have a good three-axis orientation, which will increase the accuracy of the geographic surveying of information.

We invite the developers of information equipment of all nations to install this equipment on our spacecraft. The first steps have already been taken. An agreement is being prepared with the Goddard Space Flight Center (NASA) and the National Center for Space Research of France on the installation, on Meteor 3 type spacecraft, of devices to map the ozone layer, and to obtain data on the radiation balance of the Earth.

Q: What practical and research tasks could be carried out by a constant ecological patrolling of our planet from space?

A: From orbit it is possible to track all changes in the environment caused by both natural and anthropogenic factors. In the study of the biosphere this includes tracking of dust storms, wind and water erosion of soil, monitoring of anomalous situations, drastic drying of soil or water-logging of some regions, sources of local or regional desert formation, large forest fires, outbursts in the number of pests. To study the hydrosphere an enormous role will be played by the collection of data on the state of the ocean, the distribution of drastic shifts in mountain glaciers, the formation of dammed lakes, catastrophic pollution in the case of the disposal of industrial discharges, tracking the drying of inland seas, drastic shifts in ice covers, the movement of large icebergs. In the study of the lithosphere, the detection and tracking of the development of earthquakes, volcanic eruptions, monitoring of large landslides and the sagging of land, and the development of mud flows. In the monitoring of the atmosphere, the detection of large discharges of harmful substances, especially due to accidents at plants and transportation, observation of the smoke clouds of forest fires. Of special importance is the study of the state of the holes in the ozone layer. Of importance is the remote recognition and study of accidents at atomic energy stations, chemical plants, and in freight traffic and pipeline transport.

Descriptively speaking, we should have our own specialized narrow profile portraits of Earth for scientists and

professionals; at the same time, it is very important to obtain an overall picture of the changing face of our planet.

In a global ecological system one should deploy a large number of Earth-based stations to collect emergency information with the appropriate sensors, which makes it possible to estimate the seismic state of the Earth, to measure and evaluate the chemical parameters of the atmosphere, water, etc. These stations are analogous to the KOSPAS-SARSAT system intended for the recording of signals of disasters from ocean ships and planes, should have a radio system of satellite communications with which the coded information will be transmitted to the information processing center.

Q: The KOSPAS-SARSAT system, which has saved thousands of people, is of an international character. Why then, when we speak of saving all of humanity, our common home, planet Earth, have we not succeeded in uniting the efforts of various countries?

A: Yes, unfortunately, this is so. I have already said that the USSR, USA, France, and partially Japan, are creating their own systems of ecological monitoring from space, doing parallel work without any "link-up". This is, at least, inefficient.

Regional and national points to receive information could be created ad developed using a single plan on the basis of unified, technical information and computing equipment, and common software. The development of this plan could be assumed, for example, by the International Center for Scientific Culture-World Laboratory, which is not a government organization, and which has a headquarters in Italy. And it should be ordered by the United Nations. A world ecological service, using spacecraft is vitally important for all people, and all governments of our planet.

Processing of Foton Space Cargo Begins

LD2904125290 Moscow TASS International Service in Russian 1925 GMT 28 Apr 90

[Summary] Moscow, 28 April (TASS)—A briefing at USSR Glavkosmos took place today. The journalists present were told that the Soviet and French specialists who carried out space experiments on the "Foton" spacecraft, have started processing the cargo brought back to earth.

A landing craft of the "Foton" automatic satellite landed successfully on 27 April at the predetermined spot in the country. It had on board about 500 kg of scientific equipment and materials obtained in the course of the research and experiments carried out in orbit.

The satellite was in orbit for 16 days, during which the technology of growing crystals, semiconductors, and biologically active substances in conditions of weightlessness, as well as that of the electrophoretic purification of "Alpha 2" interferon was undertaken. Experiments for clarifying the reaction of living organisms to weightlessness were carried out on newts and microorganisms.

Automatic French equipment installed on the satellite, in accordance with the commercial agreement with the National Center of Space Research of France, was used for growing albumin crystals, which will be used in the medical industry.

(Francois Gonzalez), head of the French research program, said that similar experiments will form part of the "Antares" project, under which a French cosmonaut is to go into space in 1992.

Glonass Satellites Launched 19 May

LD2105084290 Moscow TASS International Service in Russian 0743 GMT 21 May 90

[Text] Moscow, 21 May (TASS)—Three artificial earth satellites 'Cosmos-2079', 'Cosmos-2080' and 'Cosmos-2081' were launched in the Soviet Union on 19 May by the 'Proton' launch vehicle. The satellites are designed to continue the development of components and apparatus belonging to the 'Glonass' global space navigation system, which is being created to ensure identification of the location of civilian aircraft and ships belonging to the Soviet Union's maritime and fishing fleets.

The satellites were put into near circular orbit with the following parameters:

- initial period of revolution—11 hours 15 minutes:

- distance from the surface of earth—19,130 km;

- inclination of orbit—64.9 degrees.

The apparatus on board the satellites is working normally. A coordinating computer center is processing incoming information.

'Resurs-F' Photographic Satellite Launched 29 May

LD2905175390 Moscow TASS in English 1746 GMT 29 May 90

[Text] Moscow May 29 TASS—The Soviet Union launched the artificial earth satellite Resurs-F with the help of the Soyuz booster rocket today.

The satellite carries equipment designed for multizonal and spectrozonal photography to continue the exploration of the earth's natural resources in the interests of various branches of the Soviet economy and the accomplishment of ecological and international cooperation tasks.

The satellite was put into an orbit with the following parameters:

—Initial period of revolution—88.7 minutes
—Maximum distance from the earth's surface (apogee)—260 kilometers
—Minimum distance from the earth's surface (perigee)—190 kilometers
—Orbit inclination—82.3 degrees.

The equipment installed on the satellite is operating normally. Upon the completion of the flight, the exposed film will be transferred to the Priroda State Research and Production Center for processing and the subsequent distribution of the obtained information among consumers.

Under a commercial agreement, the Resurs-F satellite also carries scientific equipment of the Federal Republic of Germany, designed to conduct biotechnical experiments in conditions of micro-gravitation conditions.

'Molniya-3' Satellite Launched 13 Jun

LD1406065190 Moscow TASS International Service in Russian 0603 GMT 14 Jun 90

[Text] Moscow, 14 June (TASS)—Another communications satellite Molniya-3 was launched on Wednesday in the Soviet Union from the Molniya rocket-carrier for the purposes of ensuring the operation of a long-distance telephone and telegraph radio communication system, the broadcast of USSR Central Television programs to points in the Orbita network, and international cooperation.

The satellite has been placed in an orbit with an apogee of 40,839 km in the northern hemisphere and a perigee of 492 km in the southern hemisphere. The satellite's period of revolution is 12 hours and 18 minutes and its orbital inclination is 62.8 degrees.

Communication sessions via the Molniya-3 satellite will be carried out in accordance with the planned schedule.

Gorizont Communications Satellite Launched

LD2206080690 Moscow TASS International Service in Russian 0709 GMT 22 Jun 90

[Text] Moscow, June 22 (TASS)—In keeping with the program for the further development of the communications and television broadcasting systems using artificial earth satellites, a routine "Gorizont" communications satellite was launched in the USSR by the "Proton" satellite vehicle on Thursday. A "Mayak" [Moscow Radio] transmitter has been installed on board which is intended to continue the work being conducted within the framework of the "Intercosomos" program, to make use of new frequency bands, and set up promising systems of space communications. The "Mayak" transmitter has been developed jointly with specialists in the People's Republic of Bulgaria, the Hungarian Republic, the GDR, the Soviet Union, and the CSFR.

The satellite has been placed in a near stationary orbit with the following intitial parameters:

Distance from the earth's surface—35,788 km;

Period of revolution—23 hours 56 minutes;

Orbital inclination—1.4 degrees.

The apparatus is working normally.

[Moscow Domestic Radio Service in Russian on 22 June 0800 GMT repeats the above item but with the following addition: "The apparatus on board the satellite is being operated in accordance with the scheduled program. The transmitter's signals will be received by the Intercosmos international experimental center of satellite communications in Dubna and at the national testing ground in the GDR."]

'Marafon' Communications Satellite System Discussed

LD0106162190

[Editorial Report] Moscow Television Service in Russian at 1700 GMT on 31 May broadcasts on the "Vremya" newscast a report on a meeting of the co-founders and users of Marafon, a new commercial satellite communications system, which was held at the USSR Communications Ministry in Moscow. S. Slipchenko presents a video report on this gathering showing his interview with E.K. Pervishin, the relevant minister. Slipchenko asks what can be done to reconcile the gulf between the sophisticated communications equipment available to the Mir cosmonauts and the lack of basic telephone facilities for ordinary people in many Soviet towns.

The minister responds by alluding to plans to increase telephone production by "just over two times" in the next five-year plan period and calls for priority development of this sector by allowing the ministry to keep its earnings to invest in its own field of activity.

Over video clips of the presentation, held in a press conference format, Slipchenko notes that people are learning that you have to invest before you can reap the profits, and provides some facts about Marafon: "The Marafon system offers almost all forms of communications. It will start operating as early as 1992-93 and achieve its full capacity in 1995-96. The five co-founders are inviting cooperation, collecting money, and they estimate that the expenditure will be recouped within three to four years." However, several other commercial satellite communications systems are currently being developed, Slipchenko adds, without giving any details. This means that the monopoly is gone, and, under market rules, the strongest and most enterprising will prevail.

UDC 551.582:551.521+629.78

Some Energy Characteristics of Earth's Climatic System Determined From Satellite Observation Data

907Q0044A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 7 Dec 87) pp 3-9

[Article by V. V. Kozoderov, Computer Mathematics Section, USSR Academy of Sciences, Moscow]

[Abstract] A full theory of energy exchange in the Earth's climatic system was proposed by the author in ISSLED. ZEMLI IZ KOSMOSA, No 5, pp 3-13, 1989, and some energy characteristics of the atmosphere, ocean and land surface were examined. In continuing this research, the author makes clear that research on the Earth's radiation budget and its components from space is required at the regional level, but the theory has thus far been limited to clarification of the corresponding processes on a global scale. The various types of global energy transformations are examined. Appropriate equations are derived for characterizing the physical processes of energy interaction among components of the Earth's climatic system. Some examples are given demonstrating the possibilities of research on the climatic system on the basis of remote sensing data. The next step is an analysis of the energy characteristics within individual regions. Figures 3; references 8: 5 Russian, 3 Western.

UDC 551.593.13

Research on Fine Layered Structure of Atmosphere From Aboard Salyut-7 Orbital Space Station

907Q0044B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 11 Mar 88) pp 10-14

[Article by G. M. Grechko, V. A. Dzhanibekov and S. V. Kireyev, Atmospheric Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Photographs taken from the Salyut orbital space station revealed that thin aerosol layers in the atmosphere can be clearly observed from space and that with allowance for refraction phenomena it is possible to carry out simultaneous remote sounding of temperature inhomogeneities and disturbances of aerosol concentration. A fine vertical structure is characteristic for aerosol not only in the stratosphere, but also at lower altitudes, in the tropopause and troposphere. Simultaneous space observations of the Earth's twilight horizon and the solar disk revealed that in the altitude range of 8.5-15.5 km, there is a fine layered structure of the atmosphere consisting of at least six layers of aerosol with a vertical thickness of 600-800 m. At altitudes 3-13 km, a fine structure of the temperature field was discovered from disturbances in the shape of the solar disk. Inhomogeneities in the distribution of temperature and disturbance of the aerosol concentration in the troposphere and lower stratosphere have a layered character, and they coincide with one another in altitude with an adequately high degree of probability. It is postulated that there is a single mechanism of their formation in the atmosphere. Figures 4; references 6: 3 Russian, 3 Western.

UDC 551.24:528.77+629.78(477.62)

Ring Structures of Azov Block of Ukrainian Shield Based on Data From Space Photograph Interpretation

907Q0044C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 21 Sep 87, after revision 8 Sep 88) pp 15-22

[Article by V. G. Verkhovtsev, P. S. Veremyev and N. N. Shatalov, Geological Sciences Institute, Ukrainian Academy of Sciences, Kiev; Central Thematic Expedition, Geology Ministry, Ukrainian SSR, Kiev; Geophysics Institute, Ukrainian Academy of Sciences, Kiev]

[Abstract] The Azov block of the Ukrainian shield—a bulging of the pre-Riphean basement, a known area of extensive mineralization—is an extremely favorable area for applying new methods for studying ring structural forms. A considerable number of ring structures of different rank, genesis and age (Archean-Lower Proterozoic) were discriminated using the results of interpretation of black-and-white and color space photographs at different scales, supplemented by geological and geophysical data and a structural geology analysis. The structures were classified into three genetic types: magmatogenic, metamorphogenic and tectonogenic (each of which is discussed in detail). The magmatogenic structures, on the basis of different forms of manifestation of magmatism, are subdivided into plutonic, volcanic and volcanoplutonic Their role in the localization of mineralization is discussed and their importance for predictive purposes is emphasized. Figure 1; references 13 (Russian).

UDC 551.24:528.77:550.814+629.78(574.14)

Method for Multilevel Generalization in Study of Newest Fault Neotectonics (Exemplified by Mangyshlak Area]

907Q0044D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 23 Feb 88) pp 29-35

[Article by A. I. Timurziyev, Kazakh Scientific Research and Design Institute for the Petroleum Industry, Shevchenko]

[Abstract] The morphostructural analysis of tectonic fissuring (lineament analysis method) has been used extensively in studying the tectonics and occurrence of oil and gas deposits in the Mangyshlak area. Space photographs, aerial photographs and topographic maps

were used in determining the parameters of these structures (length, orientation, density) and in constructing maps of lineaments (more than 500 topographic bases were used). Three levels of generalization were defined reflecting the special features of tectonic fissuring in this region. The methodology used was to study the features from the particular to the general. A correspondence was established between zones of different density of lineaments and the characteristics of permeability of the sedimentary mantle determining the vertical migration of hydrocarbons and the distribution of oil and gas pools. Figures 4; references 8 (Russian).

UDC 528.85:629.13:681.3

Quantitative Estimate of Proportions of Components of Vegetation-Soil Formations from Their Reflection Spectra

907Q0044E Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 29 Oct 87) pp 42-48

[Article by S. V. Svistunov, V. Ye. Plyuta and A. A. Kovalev, Physics Institute, Belorussian Academy of Sciences, Minsk]

[Abstract] In an earlier article by the author ("L_S Solutions Method for Determining the Proportions of Information Classes Using Data From Spectral Measurements," in ISSLED. ZEMLI IZ KOSMOSA, No 5, pp 115-120, 1989), a method was proposed which is now used in determining the proportions of the components of the plant-soil cover on the basis of their spectral reflectivities. The study was made using the spectra of diffuse reflection of natural formations measured in the spectral range 0.4-0.75 μm. Five types of natural formations were studied: vegetation, sand, clay, clayey loam and chernozem. The accuracy in determining the proportions was evaluated, and the results of an analysis of the sensitivity of L_S evaluations of the proportions to possible spectral variations of the initial data are given. The influence of background components and the dimensionality of the initial space of spectral criteria on the accuracy in determining vegetation against a complex background is analyzed. The method can be effectively applied in evaluating the condition of agricultural fields on the basis of spectral measurements. Figures 2; references: 6 Russian.

UDC 528.77:631.44

Evaluation of Spectral Characteristics of Soils Using Landsat 5 TM Data

907Q0044F Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 17 Feb 88) pp 49-53

[Article by L. Juhasz and K. Kudela, Experimental Physics Institute, Slovakian Academy of Sciences, Kosice]

[Abstract] Any quantitative approach to the processing of satellite data requires allowance for many factors, such as illumination conditions, direction of sighting of the sounded surface, atmospheric parameters and local relief. A study was made to check the performance of a simplified model for taking the mentioned factors into account without an examination of the influence of systematic changes in the spectral reflectivities of features. The model includes three principal components: computation of illumination conditions for the scene in the spectral ranges of the satellite sensor; determination of background radiation by an evaluation of the minimum of a local histogram or by determining the points of intersection of the regression lines as a function of the nature of the scene; computation of the spectral brightness coefficient and brightness of features. The model was used in determining the spectral brightness coefficients of soils using data collected by the Thematic Mapper (TM) carried by Landsat 5 on 26 April 1987 over the Danube Lowland in the Czechoslovakian SSR. The results were compared with corresponding surface measurements. This comparison revealed that the proposed method is accurate to about 15%. The model also can be used in studying other types of surfaces. Figure 1; references 6 (Western).

UDC 528.81:577.4

Remote Monitoring of Vegetation Cover Polluted by Dust Effluent of Anthropogenic Origin

907Q0044G Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 23 Feb 88) pp 54-57

[Article by V. I. Kharuk, A. M. Alshanskiy and V. V. Yegorov, Wood and Cellulose Institute imeni V. N. Sukachev, Siberian Department, USSR Academy of Sciences, Krasnoyarsk]

[Abstract] An evaluation was made of the possibility of detection of pollution of the plant cover by coal and cement dust from the spectral brightness coefficients in the visible and near-IR spectral ranges. The applicability of the far-IR range for detecting temperature contrasts arising with the pollution of vegetation was also investigated. The studied features were plantings of pine (height 1.2 m) and larch (height 1.0 m), scrub and meadows. Industrial effluent was simulated by the spraying of coal and cement dust over these features in a concentration from 0.1 to 2.0 tons/hectare. Measurements were made with a spectrometer in the spectral range 410-885 nm at a distance to the feature of 2 m. Measurements in the thermal range were at 2-22 μm. Data obtained in both spectral ranges made it possible to detect plant cover pollution with a pollutant concentration more than 0.05 ton/hectare. The measurement accuracy was about 15%. Surface and aerial experiments revealed an increased brightness temperature of defoliated plantings. With small modifications, the model can be used in studying other types of surfaces. Figure 1; references 11: 9 Russian, 2 Western.

UDC 551.46.0:629.78

Problem of Interpreting Data From Remote Sensing of Water Features From Space

907Q0044H Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 25 Feb 88) pp 58-63

[Article by A. A. Gitelson and I. Yu. Kamov, Hydrochemical Institute, Rostov-na-Donu]

[Abstract] The problem of interpretation of space multiband video data for evaluating the state of water ecosystems has been traditionally solved by procedures in which the interrelationship between brightness and the concentrations of optically active components is specific for each survey. An improved method was proposed by A. A. Gitelson *et al.* in ISSLED. ZEMLI IZ KOSMOSA, No 6, pp 28-36, 1985. This method is based on the interrelationship between the spectral brightness coefficient measured at the water surface and the brightness of radiation registered by a satellite scanner, making it possible to replace measurements of concentrations of optically active components in a test sector by more easily used and economically feasible measurements of the spectral brightness coefficient. In the interpretation of the collected information, use is made of a database on the correlation of the spectral brightness coefficient and the concentrations of components. This article represents a further development of this method, a more precise characterization of its possibilities and restrictions, and a validation of the requirements on the choice of test sectors. References 12: 11 Russian, 1 Western.

UDC 535.568.1:543.47

Measurements of Spectral Polarization Characteristics of Radiation Ascending From Water Surface at Different Altitudes in the Atmosphere

907Q0044I Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 6 Apr 88) pp 64-69

[Article by A. A. Buznikov, G. A. Lakhtanov, V. M. Prokhorov and V. Ye. Churov, Leningrad Electrotechnical Institute imeni V. I. Ulyanov (Lenin); Leningrad State University]

[Abstract] Although data have been published on the degree of polarization of ascending radiation at different altitudes above a water surface, they are limited to an extremely limited set of altitudes and azimuths relative to the plane of the solar vertical, making it impossible to form an adequately complete idea concerning the influence of the atmosphere on the polarization of ascending radiation. The article gives the results of experimental research on change in the degree of polarization of ascending radiation with altitude and its spectral variation carried out at a great number of levels in the atmosphere and for different azimuths relative to the plane of the solar vertical. A semiempirical method was developed for making numerical allowance for the atmosphere in polarization measurements. The conditions for obtaining empirical coefficients for making allowance for the influence of the atmosphere are defined. Measurements were made under clear-sky conditions over the Caspian Sea by a helicopter-borne polarimeter. Data were collected at four wavelengths: 448, 525, 642 and 770 nm. Measurement accuracy was to 10-15%, demonstrating the validity of the method. Figures 3; references 13: 11 Russian, 2 Western.

UDC 551.46.0:629.78

Some Results of Analysis of Measurements of Spectral Brightness of Sea Surface-Atmosphere System

907Q0044J Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 1 Feb 88) pp 70-78

[Article by Ye. M. Kozlov and G. I. Terekhin, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] Aircraft measurements of the spectral brightness of the underlying surface-atmosphere system were used in examining some features of transformation of the statistical characteristics of the spatial structure of the field of reflected solar radiation as a function of observation altitude. The observations were made from an An-30 flying laboratory in the "Black Sea-Intercosmos" program. The spatial resolution at the surface was 2.5 x 2.5 and 80 x 80 m from altitudes 0.2 and 6.4 km, respectively. Correlations were found which indicate that, in general, in the visible spectral range there is a single mechanism of formation of the field of solar radiation reflected from the sea in which the main role is played by the attenuation of solar radiation during passage through the atmosphere. In the wavelength range 416-880 nm, the influence of the atmospheric layer is manifested differently in the average values of the brightness coefficients and their standard deviations. Figures 5; references 10: 9 Russian, 1 Western.

UDC 551.46.0:629.78

Use of Angular Structure of Radiation for Retrieving Ocean Surface Temperature From Scanner Images in IR Range

907Q0044K Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 3 Feb 88) pp 79-83

[Article by V. E. Kunitsa and S. V. Stanichnyy, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] A method is proposed for estimating ocean surface temperature from scanner information in the IR range with use of the parameters of the averaged angular structure of ascending radiation. The accuracy of the method was checked using eight cloud-free AVHRR scanner photographs for the Black Sea with the sea

surface being sighted in a rather wide range of angles (up to 68°). Averaging was carried out for surface elements observed at identical angles (perpendicular to the scan) in order to avoid variations caused by small-scale changes in surface temperature and atmospheric parameters. Up to 90 elements were averaged. The principal shortcoming of the method is the appearance of an error caused by a possible trend of surface temperature or atmospheric parameters in the direction of the scan, which could result in an exaggeration or understatement of the correction for the distorting influence of the atmosphere. Four model computations were used in determining the error of the method in the presence of an influence of the linear trends in the parameters of the ocean-atmosphere system determining the angular structure of radiation. Figures 3; references 2: 1 Russian, 1 Western.

UDC 621.398

Algorithms for Quasioptimal Representation of MKS-M Spectrometer Data

907Q0044L Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 25 Jan 88) pp 88-93

[Article by I. O. Arro and V. V. Kozhevnikov, Special Design Bureau for Computer Technology, Cybernetics Institute, Estonian Academy of Sciences, Tallinn]

[Abstract] Algorithms are proposed for the compression of measurement data obtained using an MKS-M spectrometer prior to the recording or transmission of data through communication lines. An optimal method has been used in the past which involves determination of the correlation matrix of records, its eigenvalues and eigenvectors, but this requires considerable expenditures of computer time and realistically may be infeasible on a real-time scale even with a moderate number of spectral channels. It is shown that a quasioptimal representation of data with respect to errors in the retrieval of initial information is virtually the equal of optimal representation and can be accomplished with substantially lower computation efforts. The algorithms for quasioptimal representation of data allow better physical agreement with experimental data as a result of the possibilities of ongoing adaptation. Figure 1; references 5 (Russian).

UDC 629.19:551

Classification of Space Vehicle Orbits Intended for Earth Research From Space

907Q0044M Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 (manuscript received 16 Mar 88) pp 103-111

[Article by Ye. L. Lukashevich and N. V. Kapitonova, Priroda State Scientific Production Center]

[Abstract] The results of an analysis of satellite orbits used for investigating the Earth from space, obtained earlier, are generalized. Circular quasigeosynchronous, sun-synchronous, regular, isotrajectory and other orbits which ensure ordered coverage of the Earth's surface using sensors with fixed parameters are examined. The requirements on such orbits are formulated. A general approach to evaluation of the Draconian periods of revolution and orbital radii satisfying the formulated requirements are discussed, and a classification of these orbits is proposed (in Table 2, in which the orbits are arranged in the order of increasing complexity and decreasing stability, by which is meant the capacity for maintaining the required properties under the influence of aerodynamic perturbations). The procedure used in determining the parameters of all the considered types of quasisynchronous circular orbits can be extended to near-circular orbits and can be combined with the procedure for optimizing the parameters of survey apparatus. Figures 2; references 13: 10 Russian, 3 Western.

UDC 001.83(100):[528.8+629.78]

'Caribe-Intercosmos-88' International Experiment

907Q0044N Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 89 pp 112-114

[Article by L. A. Vedeshin]

[Abstract] The international aerospace experiment "Caribe-Intercosmos-88" was carried out during the period March-April 1988 in Cuba with the participations of Bulgarian, East German, Cuban, Polish and Soviet specialists. The objective was to check the effectiveness of newly developed methods for the remote determination of different characteristics of the land and ocean (natural and cultivated vegetation, soils, agrarian geosystems, hydrological structure, relief of the shoreline and shelf, energy-active zones in ocean in the tropics) by use of materials from aerospace surveys and subsatellite surface and shipboard measurements. The work was done in three test ranges: Havana, Archipelago de los Canarios and Eastern. The space survey was made on 13, 15 and 19 April 1988 from the Mir manned orbital station, supplemented by other satellite data. A wide range of data was collected on soil moisture content, erosion, relief-forming processes, dynamics of natural and cultivated vegetation and changes in hydrological conditions, productivity of pastures, parameters of offshore fishing grounds and other characteristics of great importance for the future economic development of Cuba. The joint processing of the collected data is being carried out by the participating countries.

Alternative Proposal for Space Production, 'Polyus' Module Launch Revealed

907Q0100 Moscow PRAVDA in Russian 17 May 90 Second Edition p 3

[Report on interview with Dmitriy Alekseyevich Polukhin, head of the Salyut Design Bureau, Hero of Socialist Labor, winner of Lenin and USSR State Prizes,

doctor of technical sciences, by Andrey Tarasov; place and date not specified; under the rubric Cosmonautics of the Future: Choice of Paths and Orbits: "The Orbital Factory"]

[Text] **I would like to see serious parliamentary debates about the choice of space programs. Two, three, or five responsible firms would send their developed projects for a single national economic task and honestly compete for the piece of the budget pie allotted for it. Experts would publicly subject their beautiful plans to merciless compression or dismemberment, peering into each crack and behind each fig leaf. So that the most necessary and far-sighted will withstand all this and survive, and in 10 or 20 years there will be no "oohs" and "ahs": What have we done, where have we put this 10 billion?**

[Tirasov] Publicity and controversy constitute a simple device. But so far it is like in a battened down hold of a ship: invisible scientific and technical councils of departments and branches, unsung victories in the military-industrial commission, silent financial withdrawals, and merging of various scientific and design items.

The new promises of economic accountability and the general poverty have had their effect. The space program can barely make ends meet, and now it is demanding payment for a place on board. And where will we get the money for science that is even more impoverished? There is not enough to support it on earth, much less in space.

And if this continues, soon we really shall be merely errand boys for foreign space science. We shall carry foreign "black boxes" for hard currency and extract unique materials not for ourselves but for others, supplying developed (and also semideveloped) countries with unique pharmaceuticals, microelectronic equipment, semi- and superconductors.... Such is the tendency for which, it seems to me, there is a great future.

What can we do? To begin with we can at least start talking about it. This is what I am trying to do. An alternative plan for space technology is being brought up for discussion. Why an alternative? Because Mir-2 is considered to be the main one, the one proposed by the leading space scientific production association, NPO Energiya.

Where does the alternative come from?

From the design collective that created our outstanding orbital objects: large transport ships, the Salyut and Mir space stations, the specialized modules Kvant, Kvant-2, and Kristall which is ready for launching, and Spektr and Priroda, which are still moving along the ground conveyor.

"You mean they are also from this same 'Energiya'?" you exclaim, since you only know about a single development firm of this space fleet.

Not exactly. From its "co-author"—the Design Bureau 'Salyut' [KB "Salyut"], which today with our usual delay we are also making public as a member of the family of space rocket enterprises. it is KB Salyut's blueprints which are being embodied in the metal of orbital complexes, mainly at the Machine Building Plant imeni Khrunichev. A portrait of the firm is impossible without a meeting with the general designer, whom I have asked to answer some questions.

Dmitriy Alekseyevich Polukhin is the head of Design Bureau Salyut. He is a Hero of Socialist Labor, a winner of the Lenin prize and the USSR State Prize, and a doctor of technical sciences. He graduated the Moscow Aviation Institute in 1950, an aircraft engine specialist by education, and he later became a missile expert. He has been in charge of the firm since 1973.

[Polukhin] Our enterprise has a somewhat unusual history. For many years it was a branch of the well-known experimental design bureau [OKB] headed by Vladimir Nikolayevich Chelomey. Then it was a branch of "Energiya". But before all that it was an independent aircraft construction organization—Experimental Design Bureau-23, which was headed by none other than Vladimir Mikhaylovich Myasishchev. It existed from 1951 through 1960. This was a time of creative flourishing of one of our most talented aircraft designers. At that time our firm's specialization was the long-range strategic bomber. It was created as an aircraft with a completely original design; there were none similar either in domestic or in foreign practice. With it in less than three years our aircraft construction completed a quantum leap from bombers of the 40-ton class to the 200-ton class. For the first time our country achieved an intercontinental flight distance using turbojet engines with a cruising speed of 950-1,000 kilometers per hour. In May 1954 the aircraft flew over Red Square. And in August 1989—35 years later!—we saw it over the Tushino Airfield, at an air sports celebration, carrying the gigantic block of the Energiya rocket. That was how, with this modified machine called VM-T (Vladimir Myasishchev—transport), the Energiya-Buran system traveled to Baykonur before its launch. These possibilities were included in this remarkable machine; such was the farsightedness of its creator.

There were also other interesting undertakings, but we had to pass them by. The story of the Myasishchev design bureau, which is undeservedly forgotten, in my view deserves a discussion of its own and even a serious investigation. But at the end of the fifties, under the slogan "Rockets like sausages!," experimental design bureau-23 was transferred to Chelomey's firm for the creation of space rocket technology.... To put it simply, we were driven out in favor of slogans that were fashionable at the time, and were fashionable in a voluntaristic way. As we know, the same destiny befell the collectives of Lavochkin and Dzhaparidze, whom Khrushchev transferred to Chelomey. A gigantic firm was formed and it had nothing to do. With the irony of fate, previously many people had come here from Chelomey's organization, trying to escape his difficult character, although to be frank, he had outstanding talent. I

was one of those who had left. And then in 1960 I returned from a vacation only to find that my boss was not Myasicshchev but Chelomey again.... Well, let bygones be bygones....

In spite of the circumstances we began to work. The rocket shield of the homeland also originated here. As we know, the rocket carrier Proton, one of the most reliable in world space science, "broke off" from it. Along with it we were entrusted with "heavy" objects—transport supply ships (TKS) and long-term orbital stations (DOS). Aircraft skills came in very handy. At least in comparison to the rockets, the airplane is considerably more complicated. The ridiculous number of systems and the highest demands for reliability—we had "been through" all that and we did not have to learn it over again.

Now one can get by without telling the well-known story of the Salyut spacecraft, but for us it contains our own, deeply personal, hard-won history. An entire epic spanning many years to increase the effective life of the stations.

A decisive role was played here by the introduction of repair and restoration work on board with replacement of equipment. On the one hand there were the golden hands of the cosmonauts, their training and ingenuity, and on the other was the significant design rearrangement of the items. For there appeared a need to get at almost all the systems (and there were almost 3,000 of them in the station) and all the plug connections in the on-board cable network (and there are about 15,000 of them). And the designers had to envision all of this. This is why the wooden mock-up plays such an important role in working out the way the ship is put together—we have an entire space village, which is made with extraordinary care.

Specialized modules grew up on the basis of the large transport ship which was perfected with the launches of Cosmos-929, -1267, -1443, and -1686. The last, along with the Salyut-7 station in 1986 with leftover fuel was put into a 500-km orbit and, as you know, has been flying for a long time, confirming that the systems can operate for a prolonged period of time.

Having worked in this area as both Chelomey and Podlipki branches, we finally broke off and became an independent design firm.

Now our main concern and our main worry is the launching of Kristall. And we will be worrying about this for a long time—while the whole Mir cluster is operating in orbit. As we in space science say, the "payload masters" are the most unfortunate people. The carrier rocket operates for 10 minutes and it has finished its job, but the "payload," the useful cargo, exists for years, and it also has complicated duties. Always take your lead from the "head".

Our proposal to create an orbital plant involves the use of 20- and 100-ton modules. I shall ask my deputy for this part of the work, Vladimir Vladimirovich Pallo, to discuss this in greater detail....

[Tarasov] And another question, Dmitriy Alekseyevich, since the occasion has presented itself. Many of our readers and specialists as well have a very cautious attitude toward the Proton rocket carrier because of its toxic components. As its creator, what do you have to say about that?

[Polukhin] I say that you see before you one of the first "sniffers" of these components; I am 63 years old, and, as you can see, I am not dead yet.

[Tarasov] How did you come to be a "sniffer"?

[Polukhin] Like this. At the beginning of the sixties Captain Klimov and I, both of us in protective suits, I as the technical supervisor of the engine installation and he for the launcher, just before the launch of what was still the Proton prototype we crawled into the compartment between the tanks under the payload fairing and we sniffed to see if the drainage pipes and fueling valves were sealed tight.... We sniffed but could smell nothing. But if it were leaking we would have to postpone the launch: There would be a fire and an explosion. The team behind us was looking out from under the ground, from the bunker, waiting for a signal. You sniff and then you run to the "dugout," the nearest shelter, and from there through the trench to the boss, and you report.... Later, of course, the object was sealed so well that this unpleasant procedure was abolished.

But that is by the by. The problem of toxicity places great demands on us. How do we meet them?

First, in principle: Why are these components needed? Because oxygen and kerosene place great demands on the engine installation. Our high-boiling components can be stored for a relatively long period of time in the tank. They are hypergolic, and make it possible to make the rocket simple and economical to produce, convenient to operate, reliable during operation, and with less chance of explosion.

In the second place, upon ignition of any fuel components carbon monoxide is formed in the exhaust gases; this is the main scourge to the atmosphere. So the Proton's exhaust gases are an order of magnitude cleaner than in the so-called "clean" rockets using oxygen and kerosene.

In the third place, we must consider cases of normal launches when the components burn, and rare accidents where there is really a threat that the unburnt residues will fall to the ground. With a normal launch, the first stage falls to the ground in the marked-off region and there are certain residues of unused components. Here the oxidizer—nitrogen oxide—evaporates into the atmosphere without leaving a trace; it is a volatile component with a freezing point of minus 11 degrees. The fuel—unsymmetrical dimethylhydrazine—is partially mixed with the oxidizer and burned, and part of it falls out and

penetrates into the earth where test pits show its presence in insignificant amounts in strictly marked sections with an area of 60 by 20 meters and at a depth of from 60 to 100 cm. The residues of the second stage fall out absolutely clean— when they fall from such an altitude the components evaporate and are weathered and the atmosphere causes photodissociation of the residue. Scientists think that an altitude of more than 10 kilometers the fuel decomposes into ions. On the earth the metal residues do not even have an odor.

We have developed a program for modification of the rocket which, on the one hand, will increase its ecological reliability by completely eliminating unused fuel residues and, on the other, will increase the capacity and make it possible to put into a low orbit 1.5 times more useful cargo, and in a geostationary orbit—2.5 times more, while cutting in half the cost of orbiting the cargo. We want to use an oxygen-hydrogen boost stage [razgonnyy blok], get rid of the second stage which falls to the ground, and finally purify the first stage of unburned fuel and control more precisely where the residues land. The expenditures will be more than R1 billion less than with the other variants for the creation of new heavy-class rockets.

As you can see, here too is an alternative plan which requires broad and attentive discussion, the more so since Proton is our only heavy space rocket booster which is supplied for the next 15-20 years with a large class of all kinds of payloads and has both high reliability and the lowest cost in the world in terms of kilograms of payload placed in orbit.

But I am afraid that a decision to modernize Proton or to select an entirely new booster will be based not on an objective evaluation of the technical indicators but on "political" considerations. For example, what can we do with the super-heavy Energiya booster we have already created, which is absolutely not balanced in terms of useful loads but billions have been spent on its creation? Even the annual maintenance of the technical and launching bases for Energiya costs considerably more than modernization of the Proton would. Yet it is being suggested that we make from Energiya the kind of booster that Proton is, even if it will cost more billions. Unfortunately, our tasks are not set according to our real needs, carefully weighted, but according to the demands of monopolistic firms.

Vladimir Vladimirovich Pallo is not only the brother of the well-known designer and associate of S.P. Korolev, Arvid Vladimirovich Pallo, but he himself is also someone known in the space rocket world and a winner of the Lenin Prize. He has had to make up for a lot of lost time since he came to the rocket world late. From December 1941 through April 1945 he was in the infantry, or rather, in a brigade of marines whose path went from Vladivostok to Czechoslovakia through Leningrad, Karelia, Pechenga, Norway, and Finland. The last time, as the commander of the platoon of intelligence troops he was wounded in the Carpathians and returned home on crutches. Now it is hard to tell that he had this disability, even after he has been walking all day through the shops or launch sites of the cosmodrome. While working he completed the Moscow Aviation Institute, and he tested liquid jet engines and later Proton engines for Myasishchev. As the chief designer in his field, in the Salyut design bureau he was in charge of creating 15 spacecraft, beginning with Salyut-1, and including Mir, and the current modules. He thinks that the real history of the Salyuts has not yet been written—there was so much there that was so difficult and dramatic for the designers.

Pallo is one of those people for whom even the poor green Leninsk is like the capital because most of the time they live at the remote cosmodromes, frequently without heat in the winter and water in the summer - conditions we should have ceased to take pride in long ago. Now on the wall behind him is the schedule for testing the Kristall module (for one flight vehicle there are five test vehicles). The schedule goes from the year before last to June of this year.

[Tirasov] Can this module be called an orbital plant? And what paths to the further development of space technology do you see, since you are the creator of this equipment.

[Pallo] The Kristall module is part of the Mir complex and cannot be called an orbital plant in spite of a certain number of experimental technological installations. The installations that are part of the projected Mir-2 cannot be called a plant either. It is assigned a modest volume of space equipment—less than 2.5 tons. Mainly because space material science is only a part of the program of the manned complex. As before, many complex problems of various profiles will be solved on it—from improving space equipment and assembling large objects to geology and astrophysics. In the second place, keeping the crew—from three to 12 people—on board all the time entails a good deal of money and equipment for life support and creates vibration acceleration which cannot be tolerated with precise processes in a condition of weightlessness.... Not to mention the sharp increase in the cost of operating this unit, since for a many-year flight it is necessary to have reserve crews, rescue ships, and ground services that are constantly on the alert....

Finally the blocks of the Mir-2 station and the ships that service it will be apparatus of a new generation, which will put off their appearance for a long time even taking the necessary financing into account. And our country needs unique materials for microelectronics, biological preparations, and pharmaceuticals today, right now. We are lagging catastrophically behind the developed world, and this gap will grow each year, like a snowball. Apparently, only space technology will help to overcome it.

And so it is time to break it away from manned cosmonautics and make it an independent profitable branch of the economy. Even now, for instance, a continuous 300-hour "baking" in an electronic oven is difficult to

achieve on board Mir. And maintaining biological installations for three months? Who could tolerate spending so much time there having shut down all other activity?

We are suggesting a realistic program for producing in space unique semiconductors, optical glasses, biological preparations, and pharmaceuticals with new or improved properties. Two stages are envisioned for the implementation of this program.

The first is to create in 1993 on the basis of the existing Kvant and Kristall a 20-ton unmanned technological module (TME). It will be launched by a Proton rocket and will have 16 technological installations, both foreign and domestic, with a useful mass of up to 1,600 kg, and will be able to manufacture technological samples of the most valuable products. They will be returned in ballistic capsules and will produce the large amount of profit that will make it possible to begin the second stage.

The second stage is the creation of a 100-ton experimental plant in orbit with a productivity of about 1,000 kilograms of products per year. Let me remind you that these would be products, a gram of which costs many thousands of dollars on the world market. By then Energiya will take this giant up. We would have 20 tons of technological equipment here. These are installations which have already undergone years of testing on board the Fotons, Mir, Kvant, and Kristall. Here is an even broader field for joint enterprises and effective exchange of progressive technology and the attraction of clients from Europe, America, and Asia.

The plant would run automatically and be visited twice a year by operators for unloading, startup, adjustment, and repair and maintenance work. It will be necessary to deliver up to 20 tons of expendable materials a year. In the first two years it will be possible to return the products from the plant in the same ballistic capsules. Then it is intended to introduce a reusable ship of an aerospace system that is launched from Mriya aircraft. Development of such a system, which is much more economical than flights on Soyuz and Buran, is already being worked on by the Molniya NPO.

We also suggest considering a compromise variant which would combine for a certain time period a manned segment and the fulfillment of international duties with technological tasks. It is only a question of the time periods between visits to the complex.

Technical and economic calculations have shown that this program will be profitable for 1991-2000. The overall expenditures will amount to R1.2 billion and the value of the production materials will be in the range of 3-8 billion, depending on the kind of product and the fluctuation of world prices. The program will begin to show a profit in 1994.

We see in this a sharp leap forward for our country in the quality of the domestic radio-electronic, optical, and medical- biological industry. This is the sort of conversion which an enterprise at our level is capable of.

It is very important that our program is based on apparatus that exists and has been tested and retains the existing cooperation of scientists, designers, testers, and the test stand and proving ground base, the Flight Control Center, and the NKIK [Ground Command and Measurement Complex], and also on the colossal experience of the Moscow Machine Building Plant imeni Khrunichev.

[Tarasov] Vladimir Vladimirovich, just a minute.... Perhaps the ballistic capsules for returning cargo are lying around somewhere in the storehouses but I have never heard anything about any 100-ton piece of equipment.

[Polukhin] Well, do you remember the TASS report about the first launch of Energiya on 15 May 1987! "The second stage of the carrier-rocket placed a full size and weight mockup of a satellite at the calculated point.... But because of irregular work of the on-board systems the mockup did not reach orbit and landed in the Pacific Ocean...."

That full size and weight mockup was the 100-ton "Polyus" [Pole] module which was supposed to have a shakedown flight in orbit. This item is entirely ours and was made at the Plant imeni Khrunichev. It was a very complicated piece of equipment which was intended to demonstrate the possibility of controlling such a huge object in orbit and also to conduct a number of geophysical experiments. For this it was equipped with complicated apparatus, a number of necessary systems, and an engine installation. It is a great pity, of course, that because of an absurd mistake in one of the control blocks, delivered through a cooperative arrangement, the Polyus was not able to go into orbit. But nonetheless it was made, it was tested, and it worked successfully in interaction with the rocket. This is already a fact of space science and two years of our design effort.

In the "wooden" hall of the mockup-model shop the Polyus looks incomparably more impressive than the Mir, Kvant, Kristall, Spektr, and Priroda standing next to it.... Along with the lead designer of the "100-tonner," Yuriy Petrovich Kornilov, we measure out 35 steps along its length, and this is still with one block missing—the functional-service block. Yuriy Petrovich, flyer style, used his hands to explain what happened with the giant module. This is the kind of sadness just one improperly applied instrument can cause to thousands of people. And this, as always, after working without days off or holidays, after head-spinning commands and changes from "above," in whose fulfillment nobody believed at first.... After many months of installation and construction work at the cosmodrome, from which people used to the most intellectual labor wound up with hoarse voices and sunburned faces.

Even the wooden models are no light matter. In each item is a full interior with all the sections and models of up to 2,500 instruments.

Here is the real successor of the ancient wooden church: the testing structure for the AFU—the antenna feeder

device. There is not a single nail in the structure which rises 3.5 meters from the floor—they would impede the play of radio waves. So then, in spite of our fears, such masters have still not left old Russia. They have just moved from one branch to another.

This again suggests the idea of people who seem to have combined in themselves ancient architecture and the latest design art. Within the walls of this firm alone are the Myasishchev culture of aircraft construction and Korolev's space concepts. I am asked to name many of these talented designers such as Vladimir Konstantinovich Karrask, Gennadiy Dmitriyevich Dermichev, Nikolay Nikolayevich Mirkin, Nikolay Nikolayevich Yushkevich, and such as Vasiliy Vasilyevich Godovikov, the head of the famous aviation family—a Moscow school not far from my home was named in honor of one flier.... Such as Nikolay Grigoryevich Volkov—the father of the cosmonaut Vladislav Volkov.... These are enough not for a newspaper article but for a book. A book of life.

And I also think about how strong the stagnant discipline of our thinking is. For we have seen photographs of Energiya at its launch and have read about the "size and weight mockup." Something flickered timidly in our minds: Where, actually, is it? But it was not proper to ask that question so it was not asked.

It was on the other side, hidden by the body of the rocket. Where the Buran will be discovered next time. Hocus-pocus.

We would not want for the adoption of decisions about space to be this kind of concealed trick. We are speaking about decades of labor and billions in investments. We are speaking about the future millennium, about our children in the modern world. Let us discuss it.

Debate on Use of Nuclear Power Sources in Space

Sagdeyev Points to Danger of Nuclear Installations Aboard Spacecraft

907Q0060A Moscow NTR TRIBUNA in Russian No 3-4, Feb 90 [Signed to press 23 Feb 90] p 10

[First article of two-article spread published under a common title "Reactors Overhead" under the rubric "Controversy": "'Sword of Damocles' in Space"; article is by USSR Academy of Sciences Academician R. Sagdeyev, director of the Center for Analytical Research at the Space Research Institute; first three paragraphs are source introduction]

[Text] **Not many technical problems today trouble people as much as the safety of nuclear power. But in discussing the problems of nuclear stations on earth and in expressing and debating the pros and cons of their construction and operation, many people often forget about the radioactive energy sources that have been launched into space. Incidentally, their number (as is clear from the appended tables) already exceeds 60. And of those 60 launches, there have been nine failures, with the radioactive materials returned to earth, falling into the ocean or becoming dispersed in the atmosphere.**

How dangerous are the consequences of such space launches, and how necessary are they to humanity today? Largely contradictory points of view on these matters are held by two prominent experts—Academician R. Sagdeyev, director of the Center for Analytical Research of the USSR Academy of Sciences Space Research Institute, and N. Ponomarev-Stepnoy, deputy director of the Institute of Atomic Energy im. Kurchatov.

In publishing their remarks, we hope that other readers will take a position in this debate.

The development of the technical capabilities of civilization greatly increases the risk to humanity. Two accidents—Chernobyl and Challenger—have compelled us to revise our views as to the use of nuclear energy devices aboard spacecraft. As far back as May 1988, two organizations—the Federation of American Scientists and the Committee of Soviet Scientists for Peace Against the Nuclear Threat—made a joint proposal to ban the use of nuclear energy in space. And although this proposal has not yet had any formal results, it is gratifying that no country since then has launched spacecraft with nuclear power facilities on board.

At present, this area of scientific and technical activity is in an early stage of development. So far, both the Soviet and the American space programs call for launches with only relatively modest amounts of radioactive materials. It is all the more important today to assess realistically, ahead of time, our experiences with radioactive contamination of the environment as a result of certain unforeseen situations. After all, the long-term effects of the worst accidents involving satellites with nuclear reactors on board could be entirely comparable to the similar effects of the Chernobyl disaster. The very same may be said of the long-term effects of accidents with nuclear isotope sources containing a sizeable quantity of plutonium-238: the well-known American DIPS (dynamic isotope power system), for example, has dozens of kilograms of that material.

To get an iedea of the consequences of a launch accident, one must remember that the nuclear fuel for space reactors is highly enriched uranium: 95-97% uranium-235 and 3-5% uranium-238. The radioactivity of these isotopes is relatively low: for uranium-235 it is around 2 x 10^{-6} curie/g; for uranium-238, it is one-seventh that amount.

That means that, for today's customary amount of 100-200 kg of nuclear fuel, the total radioactivity will be about 1 curie, and even the worst-case scenario—in which the uranium block is converted into fine powder—would involve local contamination only.

However, an entirely different picture would emerge in the event of a disaster with a reactor that had already been functioning for several years in orbit. It is well known that

the total energy yield from the fissioning of uranium-235 is 204 MeV, of which 165 MeV belongs to the fission fragments.

In other words, 1 MW of thermal energy corresponds to 3 x 10^{16} fissions per second, or about 10^{24} fissions per year. That means that each year, 9 g of strontium-90 (around 2,000 curie) and 14 g of cesium-137 (also around 2,000 curie) will form in the reactor as a result of decay of the uranium. Such accumulation of biologically hazardous isotopes in the working reactor increases the risk associated with the long-term stay of powerful reactors in near-Earth orbit. For example, the SP-100 reactor being developed by NASA is expected to have as much as 2 MW of thermal power and is designed for a lifetime on the order of 10 years, after which it will have accumulated around 10^5 curie of strontium and cesium. Any accident with such a reactor could result in fallout involving a considerable quantity of those products on earth. For comparison, let us note that the strontium release of the Chernobyl reactor was 200,000-300,000 curie.

From that standpoint, the concept of so-called "safe" orbits (where the normal time of existence of a satellite is much greater than the half-life of the hazardous radioactive isotopes produced by decay) is a dangerous fallacy, if not self-deception.

Assessments that are no less ominous are obtained when we take up another type of energy source—the radioisotope thermoelectric generator (RTG). For a number of reasons (emission of alpha particles, suitable lifetime, availability), the main energy source for space power systems has become plutonium-238.

That is the isotope that is used in the Galileo and Ulysses programs, its mass being 10 kg in each generator.

Let us analyze a worst-case scenario involving an accident during launch, which would turn all the plutonium into fine powder and would scatter it in the atmosphere over great distances. The maximum allowable concentration of plutonium-238 in the air for the population is 3.7 x 10^{-18} g/l. It follows that if 10,000 g of plutonium powder were evenly distributed, the contaminated volume would be quite large—as much as 3 x 10^{21} liters, or 3 x 10^9 km^3. The volume of the earth's atmosphere (up to an altitude of 10 km), incidentally, is 5 x 10^9 km^3. And although such a straightforward estimate is quantitatively very approximate, the qualitative conclusion is obvious—such an event could prove to have global consequences.

The concept of a "safe nuclear orbit" in which reactors could exist almost perpetually without danger of falling is still doubtful. No one can deny the possibility of technical error or the danger of an accident or a collision with a meteorite—the latter could result in the explosion or breakdown of the nuclear device and the fall of the reactor or a portion of it to earth. The same outcome could result from a collision with fragments of space satellites, the number of which has been rapidly growing in recent years.

In low orbits (several hundred kilometers), the probability of such an event is already quite substantial. In high orbits (above a thousand kilometers), it is, of course, incomparably smaller. But the trouble is that there is a danger of something like a chain reaction taking place here. If, for example, a very unlikely event takes place—the collision of two large space vehicles—it would produce many fragments in those orbits, and the possibility of subsequent collisions would greatly increase. And any such collision would continue to increase the likelihood of other collisions. But maybe nuclear energy sources in space are indispensable, and we must accept them, regardless of the risk? I am deeply convinced that that is not so.

At the USSR Academy of Sciences Space Research Institute, we have analyzed in detail the prospects for launching and operating scientific stations in the near and deep space in the foreseeable future. We examined the requirements for large orbital stations, such as the Freedom, currently being developed by the Americans, or our proposed giant telecommunications platform of several dozen tons. I must say that, generally speaking, I am against this gigantomania in space, and the idea of such platform makes me think of the royal bell that was never sounded, or the royal cannon that was never fired. In my opinion, such projects are an attempt to justify the extremely expensive development of superpowerful booster rockets like our Energiya. But that's not the point. The point is that not even such space behemoths require nuclear energy sources; calculations show that their requirements can be met fully by the energy of the sun. Especially if we employ so-called solar dynamic systems, which include a solar collector and a gas turbine. Such a system, according to calculations, could produce as much as 100 kW of power or more.

The needs of space-based technology were also studied. So far, we must admit, it has not lived up to past expectations. Even now, no one talks seriously about any reasonable scale of industry in space. Moreover, the very prospect of a profitable production in orbit is in question: the use of weightlessness has so far produced no revolutionary technological breakthroughs, and it has long been cheaper to produce a space vacuum on Earth.

In a word, we have not found any projects (at least for the next 15 years) that could not be performed without the use of nuclear energy. And although further research is of course necessary here, it is already clear that a manned flight to Mars could be accomplished with nonnuclear energy sources.

The only exception is the SDI program. Here, when the station goes into the so-called "warning" mode—which might last for years, continually using up large amounts of energy—it cannot, in fact, get by without nuclear reactors.

But the more markedly world tension decreases, the less popular the idea of SDI is becoming. I recently returned from the United States and called attention to this fact.

The scientists and engineers of the Livermore Laboratory—who are among the initiators and most ardent proponents of SDI—are today becoming increasingly active in the discussion of a manned flight to Mars. Of course, it is still too early to say whether this will replace their diminishingly popular program, but I think it may well be an attempt to find a worthy way to retreat.

As a matter of fact, a unique situation has come about. The greater the friendship between our nations, the lower the military expenditures and, thus, the greater the need—in both countries—for conversion. And the paradoxical prospect is created of a collaboration between the two quite recently opposed military-industrial complexes in the area of converting a sizeable portion of the military industry into civilian industry. I believe that a mutually advantageous transfer of technology, an exchange of know-how, and plain old expansion of organizational experience with conversion will bring benefit to both governments.

Speaking at the National Press Club in Washington, I said that the new thinking and perestroyka signify, first and foremost, the abandonment of the old rubbish. I would include in this category the current and future efforts to utilize nuclear energy in space for military purposes. Moreover, I am absolutely convinced that the presence in space of a considerable quantity of even civilian nuclear sources will always tempt certain people to resurrect the idea of militarization of space, thereby increasing the destabilizing factor in the relations between our two countries.

Finally, one other important aspect of the problem. It involves the link between the development of nuclear power sources for spacecraft and the international treaty banning nuclear weapons in space. The fact is that space reactors may make it difficult to verify compliance with this treaty, since the background produced by the emissions of an operating reactor could well afford the potential violators of this treaty an opportunity to hide nuclear warheads deployed in the near-Earth space.

With all these factors in mind, we have proposed a ban on the use of any kind of nuclear device in any Earth orbit and a 15-year moratorium on reactors for other space-based uses. The only exception involves relatively low-power isotope sources in deep-space vehicles.

For such launches, we need to work out an international procedure accepted by everyone to guarantee the safety of the plutonium block in event of any conceivable accident during the launch or when the spacecraft is near Earth. And these launches would be carried out only under the supervision of an international organization such as the IAEA.

U.S.-Launched Space Craft with Nuclear Energy Sources on Board

Date of launch	Spacecraft	Power source	Mean flight altitude (in km)	Status/lifetime
29 Jun 1961	Transit 4A	RIG	930	landed
15 Nov 1961	Transit 4B	RIG	1030	inoperative
28 Sep 1963	Transit 5BN-1	RIG	1095	9 mo.
5 Dec 1963	Transit 5BN-2	RIG	1085	inoperative
21 Apr 1964	Transit 5BN-3	RIG		launch failure
3 Apr 1965	Snapshot	reactor	1290	43 days
18 May 1968	Nimbus B-1	RIG		launch failure
14 Apr 1969	Nimbus III	RIG	1100	inoperative
14 Nov 1969	Apollo 12	RIG		on moon
11 Apr 1970	Apollo 13	RIG		launch failure
31 Jan 1971	Apollo 14	RIG		on moon
26 Jul 1971	Apollo 15	RIG		on moon
2 Mar 1972	Pioneer 10	RIG		beyond Pluto
16 Apr 1972	Apollo 16	RIG		on moon
2 Sep 1972	Transit 01-IX	RIG	770	RIG running
7 Dec 1972	Apollo 17	RIG		on moon
5 Apr 1973	Pioneer 11	RIG		beyond Saturn
20 Aug 1975	Viking 1	RIG		on Mars
9 Sep 1975	Viking 2	RIG		on Mars
14 Mar 1976	LES 8	RIG	35,785	RIG running
14 Mar 1976	LES 9	RIG	35,785	RIG running
20 Aug 1977	Voyager 1	RIG		beyond Uranus
5 Sep 1977	Voyager 2	RIG		beyond Saturn

NOTE: RIG stands for the radio-isotope generator that, in all American equipment, uses plutonium-238

Soviet Spacecraft with Nuclear Energy Platforms on Board

Date of launch	Satellite	Energy source	Mean flight altitude (in km)	Flight time
3 Sep 1965	Cosmos 84	RIG	1500	
18 Sep 1965	Cosmos 90	RIG	1500	
27 Dec 1967	Cosmos 198	reactor	920	1 day
22 Mar 1968	Cosmos 209	reactor	905	1 day
23 Sep 1969	Cosmos 300	RIG	emergency return to earth	
22 Oct 1969	Cosmos 305	RIG	emergency return to earth	
3 Oct 1970	Cosmos 367	reactor	970	1 day
1 Apr 1971	Cosmos 402	reactor	990	1 day
25 Dec 1971	Cosmos 469	reactor	980	9 days
21 Aug 1972	Cosmos 516	reactor	975	32 days
27 Dec 1973	Cosmos 626	reactor	945	45 days
15 May 1974	Cosmos 651	reactor	920	71 days
17 May 1974	Cosmos 654	reactor	965	74 days
2 Apr 1975	Cosmos 723	reactor	930	43 days
7 Apr 1975	Cosmos 724	reactor	900	65 days
12 Dec 1975	Cosmos 785	reactor	955	1 day
17 Oct 1976	Cosmos 860	reactor	960	24 days
21 Oct 1976	Cosmos 861	reactor	960	60 days
16 Sep 1977	Cosmos 952	reactor	950	21 days
18 Sep 1977	Cosmos 954	reactor	emergency return to earth	approx. 43 days
29 Apr 1980	Cosmos 1176	reactor	920	134 days
5 Mar 1981	Cosmos 1249	reactor	940	105 days
21 Apr 1981	Cosmos 1266	reactor	930	8 days
24 Aug 1981	Cosmos 1299	reactor	945	12 days
14 May 1982	Cosmos 1365	reactor	930	135 days
1 Jun 1982	Cosmos 1372	reactor	945	70 days
30 Aug 1982	Cosmos 1402	reactor	emergency return to earth	120 days
2 Oct 1982	Cosmos 1412	reactor	945	39 days
29 Jun 1984	Cosmos 1579	reactor	945	90 days
31 Oct 1984	Cosmos 1607	reactor	950	93 days
1 Aug 1985	Cosmos 1670	reactor	950	83 days
23 Aug 1985	Cosmos 1677	reactor	940	60 days
21 Mar 1986	Cosmos 1736	reactor	950	92 days
20 Aug 1986	Cosmos 1771	reactor	950	56 days
1 Feb 1987	Cosmos 1818	reactor	800	approx. 6 mos.
18 Jun 1987	Cosmos 1860	reactor	950	40 days
10 Jul 1987	Cosmos 1867	reactor	800	approx. 1 year
12 Dec 1987	Cosmos 1900	reactor	720	approx. 124 days
14 Mar 1988	Cosmos 1932	reactor	965	66 days

Both tables reprinted from SCIENCE AND GLOBAL SECURITY, No 1, 1989, pp 96, 97.

[Box, p 10]

- 1964. The American navigational satellite Transit with a radioisotope power source on board is not able to achieve orbit. The device with plutonium-238 breaks up in the atmosphere and is dispersed across the globe. Around 17,000 curie of plutonium-238 was released into the environment, three times more than its content of this isotope.
- 1965. The only reactor placed in space by the U.S. malfunctions after 43 days. Even though the satellite was moved to a high, long-duration orbit, according to certain reports, it had already begun to fall apart.
- 1968. The American weather satellite Nimbus, containing plutonium energy sources, suffers greatly from an unsuccessful launch. These energy sources fall into the ocean not far from Santa Barbara (California). They are found five months later.
- 1969. Two unmanned devices are launched by the USSR in the autumn to investigate the moon. Several days after the launch, both return to the atmosphere. It is believed that one or both of them carried polonium-210: according to certain reports, radioactivity was detected in the atmosphere after the return of the vehicles.
- 1970. The Apollo 13 moon flight fails. The lunar module is jettisoned and lands in the Pacific Ocean with its plutonium power-support unit on board.
- 1973. Due to an accident during launch, a Soviet satellite with nuclear reactor on board falls into the Pacific Ocean north of Japan.
- 1978. Possibly the largest accident thus far: Cosmos 954 enters the atmosphere and breaks apart, scattering thousands of radioactive fragments over 100,000 square kilometers in the northwestern regions of Canada. The Soviet Union pays Canada sizeable monetary compensation.
- 1983. The radioactive core of the reactor of Cosmos 1402 returns to the atmosphere, breaks up, and disperses its radioactive reserves.
- 1988. Radio communications with Cosmos 1900, launched in July 1987 and carrying a nuclear reactor on board, are lost in April 1988. The absence of communications prevents sending it a command to move to high orbit, and by the middle of September of the same year it slowly loses altitude, gradually coming closer to earth. Only on 30 September, several days before entering the dense layers of the atmosphere, is the protection system activated, and the satellite ascends to a safe stationary orbit.

(Taken from an article by D. Hirsch, president of a working group on use of nuclear energy in space, of the Federation of American Scientists: "Soviet Reactors for SDI?" MEZHDUNARODNAYA ZHIZN [International Life], No 12, 1989).

Ponomarev-Stepnoy Rebuts Arguments of Nuclear Dangers in Space

907Q0060B Moscow NTR TRIBUNA in Russian No 3-4, Feb 90 [Signed to press 23 Feb 90] p 11

[Second article of two-article spread: "Onward to Nature!"; article is by USSR Academy of Sciences Academician N. Ponomarev-Stepnoy, deputy director of the Institute of Atomic Energy imeni I. V. Kurchatov]

[Text] Accidents with Soviet and American satellites carrying nuclear power sources have greatly agitated world opinion. This alarm became especially acute after the mishap with Cosmos 954 in 1978 and the almost disastrous failure of Cosmos 1900 ten years later. The result—a strong movement against nuclear reactors in space.

People's fear of another Chernobyl—wherever the threat might be, in space or on Earth—is a very grave matter that cannot be assuaged with assurances like "My word of honor, there won't be any more explosions." It is not surprising, therefore, that scientists engaged in nuclear power engineering (particularly that in space) appear to be medieval "vivisectionists" or "mad professors" from a Hitchcock horror movie in the eyes of the majority, who have lost faith in science. Since I am now professing the necessity of nuclear power in space, I am afraid that I, too, will be put in that category. It is therefore gratifying that the debate with my opponents (especially R. Sagdeyev) has become worthy of the press. This allows both sides a chance to express their opinions.

As strange as it may seem, my position and that of Roald Zinnurovich [Sagdeyev] are more similar than they are different. We both consider the first and essential condition for development of space-based nuclear technologies to be their safety, but we use semantically opposite imperatives: one side says "Yes, they may be used, with the exception of such and such instances"; the other actually reiterates that by saying "In such and such instances, they may not be used." The main difference is in the intent: "to prohibit, because it is dangerous" versus "to permit when it is safe."

Really, I have no faith whatsoever in the effectiveness of such prohibitions. However enticing from the standpoint of safety the slogan "Back to Nature!" may appear, it is not true, if only because it cannot be carried out. Much more logical, in my view, is the slogan "Onward to Nature!"—to a Nature protected against the sinister consequences of scientific and technical progress by scientific and technical progress itself.

Man's drive to outer space, like the process of learning itself, may be prohibited, but it cannot be prevented. In one way or other, space will be developed—on this score, it would appear, no one expresses any doubt. The main training ground for the space program today is near-Earth orbit. A multitude of problems are being worked out there at present—problems that are purely scientific,

as well as those that are principally applied (communications, meteorology, geology, navigational support, development of revolutionary technologies, etc.). The next step is the conquest of the distant orbits and flight to other planets. None of these missions could be performed without a suitable energy supply, and the greater the distance, the more necessary this becomes.

The energy requirements of the space program today are measured in kilowatts and, at rare times, in tens of kilowatts. Tomorrow, hundreds will be needed—for the same development of technologies. And expeditions will require megawatts. Where will we get them? Neither wood, nor coal, nor wind engines, nor heated water are, of course, appropriate. The energy sources available in space can be counted on one hand. There are three—chemical, solar, and nuclear.

Chemical energy sources are good when it is a question of a short time of operation in space (on the order of several days or weeks). When the spacecraft is required to operate for months or years, the weight of the chemical fuel components that must be placed in orbit becomes a serious hindrance. The best solution in this case is to use the energy of the sun. All of this relates to comparatively low levels of energy consumption (on the order of 10 or 20 kilowatts). As soon as more energy is needed, one must also abandon solar batteries. Not only because of the increasing weight, but also because the controllability of the space vehicles is drastically impaired by the large areas of the photocells.

Thus, for long periods of time and large energy expenditures, nuclear sources have no replacement. Of course, that does not mean that they should be used everywhere, if there is a reasonable alternative. The important thing is the question of safety, and therefore we should immediately remove from the "purview" of nuclear power those cases in which it might lead to fallout of a dangerous quantity of radioactive substances on Earth. For example, satellites with nuclear reactors on board should not be launched in low near-Earth orbits, since over time they might lose altitude and return to earth in the form of radioactive fragments.

Yet, space itself furnishes us with a unique opportunity to perform a kind of "ecological" exploration of the questions of safety and application of nuclear energy in space. The safety of a space vehicle with a nuclear energy source on board is automatically secured if the ballistic characteristics of its orbit prevent the vehicle from reaching Earth for several hundred years. Our opponents declare that even here, in the high orbits, nuclear engineering should be prohibited, since there exists a finite probability of the space vehicle colliding with the fragments of defunct satellites and subsequently returning to Earth. Such an argument, in my opinion, does not suit a scientific debate. The magnitude of such a probability, although it is finite, is very small at present. Unfortunately, I am not myself able to give the specific figure either, since it is the result of very hypothetical calculations; but neither that probability nor the present experience with outer space (since 1957, despite a huge number of launches, not a single collision has been detected) gives us reason to believe that the likelihood of a collision is large enough that one may be expected for, say, centuries. This probability must be computed, of course, and we are working on that today. In January, at a conference in Albuquerque, we talked with American scientists about organizing this work together.

Naturally, the safety of space vehicles with nuclear reactors on board has not always gone smoothly—this is evident from the list of accidents presented here. But over the course of time the safety systems have been improved (and are continuing to be improved), as a result of which, incidentally, the incident involving Cosmos 1900 had a good ending. Cosmos 1900 was outfitted with several emergency systems. It was to be expected that one of these might fail (the first system failed), but it is much harder to imagine a situation in which all systems would fail. Of course, equipment failures like that which occurred in Cosmos 1900 are intolerable, but I would not, as did our opponents, declare the satisfactory outcome of the incident a miracle. The opposite, perhaps, would have been a miracle (of an opposite nature).

As a matter of fact, in my opinion, the arguments presented against nuclear power in space are not always justified, nor are they always valid. For example, it is hard for me to understand how a person who is competent is engineering could compare the long-term effects of an accident involving a space nuclear reactor and the long-terms effects of an accident involving a reactor like the one that blew up in Chernobyl. The capacity of the first is around 100 kW, whereas the capacity of the Chernobyl power unit was 1000 MW. The total radioactivity of the reactor is proportional to the energy produced.

And I have no idea what to make of the recent statement in the press that said that last year Soviet scientists offered the Americans their own nuclear reactor for use in SDI. In actuality, the reverse is the case: for already a year the scientists of the USSR and the United States have been studying very carefully the issue of changing-over space technology, including nuclear power engineering, from military to peaceful objectives. Last year, the American company Space Power, Inc., came to us with a proposal to create by joint venture a satellite for worldwide broadcast of high-resolution television programs, multichannel telephony, and navigational support of all kinds of air and marine transport. The value of such a satellite to all the inhabitants of Earth is hard to exaggerate—it represents a qualitatively new level of communications, an immeasurably greater degree of safety for airplanes and ships. But such multichannel system requires appreciable power, which can only be provided by a nuclear reactor. In January 1990, at a conference in Albuquerque, these negotiations were resumed. Incidentally, one other very interesting and, in

my view, extremely imaginative project using nuclear reactors was discussed there—use of nuclear reactors not in outer space, but on the surface of the Moon, to provide the energy for future colonies.

I repeat: I can only welcome any open debate on the possibilities and dangers of nuclear power in space. I do not at all consider my point of view to be the last and final truth, and I am ready to change it, if reasonable and scientifically grounded objections are presented. But I have yet to hear any. I have always felt, and still do, that it is more proper to safeguard the operation of a needed piece of equipment than to ban it.

Conference on Nuclear Power in Space Opens

PM1705151790 Moscow KRASNAYA ZVEZDA in Russian 17 May 90 First Edition p 1

[TASS Report: "Conference on Nuclear Power"]

[Text] Obninsk (Kaluga Oblast), 15 May—An industrial scientific conference "Nuclear Power in Space," organized by the USSR Ministry of Nuclear Power Generation and the Nuclear Industry, began work here today.

Every step that mankind takes in exploring space demands a significant expenditure of energy. Until now the only source of energy aboard spacecraft has been solar batteries. The first thermal emission nuclear electric power installation in the world, "Topaz," which is a power plant to be used on board craft intended for work in inner and outer space, has recently been successfully tested in the Soviet Union. The main participants in developing it are the Physical Energy Institute where the conference is being held and the "Krasnaya Zvezda" science and production association.

Leading specialists from the Soviet Union, the United States, France, Great Britain, the FRG, and Holland are participating in the work of the conference. The most important tasks facing them include guaranteeing total radiation safety in the operation of the nuclear reactor in space.

Deep Space Communication Center at Yevpatoriya

907Q0062 Moscow KRASNAYA ZVEZDA in Russian 22 Mar 90 1st ed p 4

[Article by B. Sopelnyak, special TASS correspondent, for KRASNAYA ZVEZDA: "The Secret of Facility MV"]

[Text] The formidable warship was reaching the end of its days. The flag was already lowered, the crew was already transferred to shore, but neither the sailors nor the officers had left the pier—they simply could not believe that they were seeing for the last time the ship that had become their home, that it had been ordered, as they say in the navy, to be rafted down the river to splinters. Someone recalled that the pride of the Russian and Soviet navy, the battleship Sevastopol, had taken part in the heroic defense of the city, in whose honor it was named; another one went even further in his reminiscences...

When the towing hawser had been attached and the ships standing alongside mournfully blew their whistles, a group of civilians appeared on the pier, accompanied by two admirals. A stout with a big forehead and a dark coat glanced at the ship with an imperious look and said curtly: "As you were!"

The admirals immediately rushed to carry out the command. The man in the dark coat went on deck, moved around the main gun turret, carefully regarding the 305-mm guns. He kicked the armor for some reason and then turned to his slender, gray-haired companion.

"What do you think, Mstislav Vsevolodovich, will it do?"

"It will, Sergey Pavlovich. It will do quite well!"

Thus, the gun turret of the battleship destined for the scrap yard was given a new life. And what a life!

The late fifties... The first artificial Earth satellite had just been launched, the amiable Layka had not yet been to space, a manned spacecraft had not yet gone up—and even so, S. P. Korolev and M. V. Keldysh were already making calculations for flights to the Moon, Mars, and Venus and were dreaming about the probing of deep space. In December 1957, an article by Korolev appeared in PRAVDA under the pseudonym K. Sergeyev. In it he wrote: "There is no doubt that the quest for new and better space rockets will continue, unmanned spacecraft will be developed, and, finally, other planets will be reached."

Korolev's vision came true, as it were, right before everyone's eyes. Ultrapowerful rockets were built, spacecraft were developed, and satellites went into the uncharted reaches of space. But how was all of this to be controlled? How would the incoming information be received and processed? It was at this time that a project was undertaken to build "eyes and ears," as well as "arms," that would reach out to the spacecraft and satellites—an antenna for deep-space communications. The deadline was eight months. No one had any experience with such matters, and there were only a handful of specialists, but Korolev's people took up the task enthusiastically. A site was selected outside Yevpatoriya, right on the seashore. A crater was dug out of the rocky ground, the foundation poured, and one of the enterprises made eight "dishes" of 16-meter diameter. But what would they be mounted on? After all, an antenna is supposed to rotate in all planes. And that's when Korolev thought of the battleship... The gun turret was placed right on the foundation; on top of that, the open framework of a railroad bridge; on the frame work, the solid hull of a scrapped submarine; and on the hull, finally, the eight antenna "dishes."

At the appointed time, the ultrasecret "Facility MV" was ready. It consisted of three complexes: one was designed to send commands, the other two to receive the incoming information. The effective radius of the antennas was 300 million kilometers, and the sensitivity was so high that they could catch the signal from a match struck on the moon! In time, the power of these now obsolete antennas no longer satisfied the scientists, which is why a new one was built in 1979 and was designated RT-70. The diameter of its mirror was 70 meters, and the effective radius, one-and-a-half billion kilometers. This radiotelescope was created under the direction of Chief Designer M. S. Ryazanskiy.

"I came here when the work was, as they say, in full swing," recounts former chief engineer of the Deep Space Communication Center, V. Vinogradov. "Not everyone today remembers that this facility was built by the military, the Red Banner Black Sea Fleet, which is why it wouldn't be a bad idea to attach a commemorative plaque to the base of the antenna. And all the command-and-telemetry position were manned by uniformed personnel. It is no secret now, but at that time it was a highly classifed secret that satellites were flying in space and working not only for scientific ends, but also for the national defense. Today, more and more, one sees civilians here—engineers and scientists working on specifically scientific and economic projects."

"Thirty-three years ago," recalled the senior specialist of the center, M. Kalinkin, "when the Deep Space Communication Center and the system of ground-based measurement complexes were being built, neither Korolev nor his associates used the term 'conversion.' But having taken part in that work, I can state with complete assurance that the system was indeed based on the idea of conversion. Judge for yourself. We can control space vehicles of military, scientific, or economic missions with the same antennas, computers, and communication channels. Exploration of the planets of the solar system; study of the galaxy, quasars, "black holes"; provision of radio and television communications to remote regions of the country; observations made from space—these represent just a partial list of the problems that can be handled by space technology. Let me stress that the same specialists handle all this.

"I am thinking, you know, of how complicated, important, and expensive the project we are working on is," says Kalinkin. "We are faced with crucial tasks. And we will surely accomplish them, but... There are a lot of 'buts,' and it is hardly the place to discuss them here. But I would like to speak of one. The dismissal of military specialists from the ranks of the armed forces on account of age. Highly skilled operators who, at 45 or 50 years of age, are still in good 'combat shape'—is that really old? And it took money to train them, and quite a lot of it. Even so, how can you express in monetary terms the experience that they have garnered, performing in the most varied of situations? To nurture and multiply the intellectual potential of the nation—that was another one of the commandments of Korolev. I am convinced that, if we follow it, we will make the most daring dreams come true, both in space and on Earth."

Space Policies, Personalities Assailed

907Q0097A Moscow MOLODAYA GVARDIYA in Russian No 4, Apr 90 pp 192-207

[Article by German Nazarov: "You Cannot Paper Space With Rubles: How To Save Billions"]

[Text]

Polemic Notes

The space program originated during the period of Stalin's government. But I date this period from 1934, from the 17th Party Congress, when Stalin managed to take the administration of the country into his own hands. It is precisely during this period that Russian songs began to resound again in Russia, Russian history began to return to school textbooks and the silhouette of the "leader of the world proletariat," Leyba Trotskiy, flew out of the school notebooks, along with his quotation: "Gnaw the hard granite of science with young teeth." The film "Petr I" appeared on the screens of the movie theaters. No longer thrown out of A.S. Pushkin's poem "Yevgeniy Onegin" was the word "Russian" in the phrase "the Russian soul." Pushkin's verses "To Russia's Slanderers," previously banned as allegedly chauvinistic, began to be printed again.

Attempts are being made to present Stalin to our present-day young generation of "builders of communism" (or, after Khrushchev's removal—"of developed socialism," or, after Brezhnev's death—"of renewed socialism") outside the time during which he led the country. History gives different assessments of his activities and this cannot be disregarded. Let us recall the words of the English prime minister, W. Churchill, spoken by him in December of 1969 in the House of Lords on the occasion of the 90th Anniversary of Stalin's Birth: "Very fortunate for Russia was the fact that, during the years of terrible ordeals, it was headed up by the steadfast general, I.V. Stalin. He was a remarkable personality, who impressed **our cruel times,** through which his entire life flowed. Stalin was a man of unusual energy, learning and unbending willpower: harsh, cruel and ruthless both in deeds and in words, with whom even I, well-bred in the English Parliament, cannot contrast anything... This was a man who destroyed his enemies by his enemies' own hands and forced us, whom he openly call imperialists, to fight against imperialists... He received a Russia with a wooden plough, but left it equipped with atomic weapons."

And, I would add, with an intercontinental ballistic missile.

With regards to the present-day revilers of the history of our people and country, they are pursuing well-defined goals: to draw attention away from the period of the

government of the Khrushchev-Brezhnev clique and to shield from responsibility behind the smoke screen of the criticism of Stalinism those state and party figures who, under the cover of the so-called "collective leadership," drove a mighty power "to the brink of despair," when no one was answerable for anything.

During the pre-war years, when the best technical minds of Europe and America were working on the development of ballistic missiles, the attempts to arm our army with missiles came up against an absurd lack of understanding on the part of the technical staff of the head of weapons of the RKKA [Workers and Peasants Red Army], who was directly subordinate to Tukhachevskiy. Even a comparatively simple rocket weapon like the "Katyusha" [multi-barreled vehicle-mounted rocket launcher] was not valued at its true worth by Tukhachevskiy.

The leading specialists in our recent history, led by Roy Medvedev, assert that Stalin did not understand anything and therefore impeded the development of rockets. But it was precisely he who, during a difficult and alarming time for the country, selected what was best in all respects and within the capabilities of our industry, namely, the development of the field rocket artillery (the "Katyusha"). The hypothetical expensive projects which certain inventors, supported by Tukhachevskiy at the time, were trying to impose were rejected as impractical and unrealistic.

Soon after the end of the war, our country was confronted with the urgent need to give a proper response to the political blackmail unleashed by the USA, whose strategic capabilities included the atomic bomb and the long-range military aircraft as the means for its delivery. This most complex task had two technical aspects—the development of an atomic bomb (and later a hydrogen bomb as well) and a missile capable of delivering it to the target.

The need for ensuring the work on the development of new branches of technology and production was noted at the first session of the Second Convocation of the USSR Supreme Soviet in March of 1946. Pertinent to such work were the research on the development of rocket technology, the use of new types of engines (jet aircraft and rocket) and the use of nuclear power for industrial purposes.

In order to ensure the country's further technical development, it was necessary to expand and establish new experimental enterprises, design bureaus and scientific research institutes and to encourage in every way possible the scientific research work of the scientists and engineers. Soon after the USSR Supreme Soviet session, this type of enterprise did begin to be established. The first government decree on the development of ballistic missiles in the USSR was signed on 13 May, 1946. And this was at a time when 1,700 of the country's cities lay in ruins. The population losses were estimated to be in the tens of millions.

On 9 August, 1946, by order of USSR Minister of Weapons D.F. Ustinov, S.P. Korolev was appointed chief designer for the development of ballistic missles.

The following must be said here. Our left-radical press trumpeted the fact that Stalin sent Korolev to prison in 1938. In actuality, the matter was not quite so. Or more accurately, totally not so. It is known that, with the advancement of Trotskiy and his comrades-in-arms (of the 21 members of the Central Committee "elected" in August of 1917, 2 months prior to the revolution, 20 were his supporters) to the leading roles in the party, they, in addition to the blunt extermination of the "bourgeoisie" and the members of their families, practiced denunciation—a well-tested provocation method which had "proven" its value during the years of the civil war and which frequently led to the physical destruction of people. People were also shot for non-denunciation. It was precisely as a result of denunciation that Korolev was sentenced to 10 years. Already at Kolyma (he was arrested on 27 June, 1938), he wrote from Madyak mine to A.Ya. Vyshinskiy: "...I have been foully slandered by the institute director, Kleymenov, his deputy, Langemak, and engineer Glushko." It is precisely as a result of the interference of Stalin, who was interested in the state of rocket technology and to whom the lists of convicts were submitted, that Korolev was rescued from Kolyma.

Stalin assigned to Korolev and his collective the tasks not only of developing a rocket whose characteristics would be in no way inferior to the German V-2 rocket, but also of searching for an efficient design with much higher technical flight and operating characteristics. From 18 October through 13 November, 1947, tests were conducted in the USSR at Kapustin Yar, the artillery firing range which has finally been opened up for public inspection, of the V-2 rockets put together from units manufactured in and brought from Germany. In all, 11 launches were conducted. Korolev's study of the tested equipment showed that the designs used in the V-2 rocket, to a large extent, were outmoded: suspended fuel tanks, an inseparable nose cone, an inadequately accurate guidance system and unjustifiably complicated systems, assemblies and units.

Korolev proposed developing a more improved rocket designed for a range of 600 kilometers, which was immediately reported to Stalin. At the same time, it was decided that, while continuing the work on the development of promising rockets, the R-1 rocket (similar to the V-2) would be developed in parallel in the briefest possible time frame, so that, during the process of mastering it, our domestic industry would accumulate specific experience in the production, testing and operation of large rockets, thereby preparing to cope with future rockets of more improved design and securing the time advantage, even if it partially made up for the losses inflicted by the war.

Over the course of 1 year (!), the first domestic R-1 guided rocket was designed, built and tested. The first launch took place on 10 October, 1948. The rocket's

flight went normally and it reached the target. The tests of the first series of R-1 rockets confirmed the correctness of the solution of all the main problems associated with the development of rockets with a flight range of up to 300 kilometers. The development of the rocket required widespread cooperation in the efforts of the scientific research institutes, the design bureaus and Soviet industry's plants, part of which had shifted to the production of peaceful goods. Suffice it to say that 13 scientific research institutes and design bureaus and the collectives of 35 plants had been engaged in this work.

In December of 1949, Korolev's collective had worked out the draft plan for the R-3 rocket which had a range now of 3,000 kilometers and a launch mass of 72 tons. This plan was characterized by a key innovation, the scale of the problems posed and the questions which arose during their solution. The plan for the R-3 rocket was not realized, since, during the process of its development and the tests of the experimental rockets on which the principles laid out in it were being tested, the possibility and advisability of a direct transition to the development of rockets designed to achieve intercontinental range were demonstrated.

The country healed the wounds inflicted by the war and built the rockets. We were driven to this by the international situation which had developed. Since 1951, integrated research had been conducted on single-stage and two-stage ballistic missiles. On 13 February, 1953, Stalin sanctioned the plan for work on the development of intercontinental ballistic missiles (MBR's [ICBM's]).

The capabilities of the Soviet Union, the experience accumulated during the development of the single-stage rockets and the intersectorial cooperation, already established by that time and clearly functioning, naturally, foreordained the further concentration of the country's efforts on the development of the two-stage rocket, which represented in those years the post efficient means for achieving intercontinental range. On 20 May, 1953 (already after Stalin's death), G.M. Malenkov signed the decree on the development of a specific ICBM, the R-7 rocket. The question arose about the necessity of developing an essentially new weapon.

Simultaneously, launches were continuing of the rockets which had been put into operation. At the same time, the resistance and heating of bodies during flight and reentry into the atmosphere were being studied, systems had been tested for returning nose cones from high altitudes and biomedical problems were being studied. All these questions found further application during the development of space vehicles for various purposes.

The initial research on the possibility of the practical implementation of launches of a manmade satellite of the earth (ISZ) using the rockets developed under Korolev's supervision was performed by M.K. Tikhonravov. Since 1950, the group headed by Tikhonravov had performed a large amount of preliminary work under the title "Research on a Manmade Satellite of the Earth," in which a study was made of the most advantageous conditions (from the point of view of power consumption) for putting a satellite into orbit. This work of an exploratory nature played a specific role in the future.

In subsequent years, when power shifted to a party adventurer, a staunch pupil of Lazar Moiseyevich Kaganovich, N.S. Khrushchev, and later to L.I. Brezhnev, their idolaters attributed not to Stalin, but rather to them, the paternity of the organization of the work on rocket technology and the space program. The obstinate facts say otherwise.

But how was the development of ICBM's getting along in the USA? It is necessary to know this in order to compare later on the achievements of the two space powers. The skeptical attitude toward rocket weapons, which was prevalent among the representatives of the American military department, radically changed right after the appearance of allied intelligence reports about the work being conducted in Fascist Germany on the development of the V-2 (A-4) rocket. Even then, the USA began to exert a great deal of effort in order, on the one hand, to obtain for its own use specific data about the German rockets and, on the other hand, to conceal them from the USSR.

This was facilitated by the circumstances which had developed. On 18 August, 1943, after the mass raid of the Joint Anglo-American Air Force on Penemuende, a new firing range was built in Nazi-occupied Poland for tests (the Penemuende range was completely restored in October of 1943). Since the rockets sometimes fell at a significant distance from the regions where the German field commands expected them, partisans from the Polish Resistance Movement got hold of and sent to London in the middle of 1944 certain important parts of the V-2. At the very same time, parts of a V-2 rocket which had fallen in Sweden after a launch from Penemuende had been delivered to London.

In his message to Stalin on 17 June, 1944, W. Churchill reported that "Hitler has begun to use his secret weapon against London." In his message of 25 June, lulling Salin's vigilance, he noted incidentally: "...You may calmly pay no attention to all the German nonsense about the results of the action of their flying bombs..." Two days later, W. Churchill again returned to the theme (which could not help but alarm even him, an inveterate politician) and he again noted, in passing as it were: "With regards to Hitler's airplane-bomb, this means, as is evident, cannot be of serious importance."

What speaks of the interest displayed in the USA in the new weapon is the fact that, before the allied landing in Normandy, the American military command had carefully worked out a plan for a secret operation, "Paperclip," which had as its goal the capture of German rocket scientists. The V-2 rocket's chief designer, W. von Braun and his group significantly facilitated this task by surrendering to the advance American units in April of 1945.

Within U.S. military circles, as before, the opinion prevailed that ordinary airplanes or missile airplanes with jet engines were the best means for delivering atomic weapons to an enemy's territory. From the military point of view, a long-rang ballistic missile was not considered to be an adequately effective means in this respect.

The work on the project for the first experimental MX-774 rocket was begun in 1946 by the Convair company and was basically completed in the middle of 1947. Externally, the MX-774 was reminiscent of the V-2 rocket, however, in its design, it differed significantly from the German rocket (a reduced launch mass as a result of the shift to thick-walled fuel tanks with pressurization, a separable nose cone, gimbal-mounted engine combustion chambers and so on). In June of 1947, the contract for the research work on the MX-774 rocket was canceled, however, over the course of the period from June through December, 1948, three test launches were conducted. All three were unsuccessful.

After this, work in the field of the development of ballistic missiles was conducted on an insignificant level and it was only after it became clear in September of 1949 that the USA no longer had a monopoly in the field of atomic weapons that attention was again turned to the development of ballistic missiles. In January of 1951, the Convair company was given a contract for research and experimental work on the MX-1593 project, which required a comparison of the potential capabilities of the ballistic and gliding missiles. The work was conducted based on the development of the MX-774 rocket.

In September of 1951, the MX-1593 project received the name Atlas, however the project's development proceeded at a slow pace. In 1953, a special committee, established by the U.S. Air Force and made up of prominent scientists, reviewed the plans for the development of an ICBM and submitted a number of recommendations and findings which confirmed that an ICBM could be developed for adoption as a weapon in the years 1960-1962. After the recommendations of the indicated committee, the Atlas ICBM project was thoroughly reviewed. In January of 1955, the Convair company received a contract for the development of the revised ICBM project, which received the designation of M-65. The work received a high priority and, in September of 1955, this project began to be developed according to an intensified program. The work which had unfolded in this field in the USSR also urged the USA on.

The first experimental launch of the Atlas ICBM took place on 11 June, 1957, and ended in failure. Only on the 15th launch was the calculated flight range of 10,200 kilometers achieved.

The powerful impetus given during Stalin's time to the development of rocket technology made it possible in May of 1957 to conduct the first launch of an intercontinental ballistic missile, which, in August of 1957 (with the fourth attempt) showed the calculated flight range. This was published in all the newspapers. And on 4 October, 1957, this ICBM, which was called Sputnik, launched the world's first manmade satellite.

The competition with the Americans in the initial stage of development of rocket technology had been won. But only 12 years had passed since the end of the war! We also led the USA in the launching of the first man into space. Khrushchev was praised as the father of Soviet cosmonauts. He showered Hero's Gold Stars on the participants in the development of the rocket and the spaceship. He also did not forget his close circle and himself. But the foundation for this success had been laid by Stalin.

The "workhorse" for ensuring all the space programs during Khrushchev's time was the R-7 rocket. But this "workhorse" began to wear out and could not keep up with the march of time. Khrushchev constantly urged Korolev on, demanding the impossible from him. The first big successes in the space program made it possible for Khrushchev to stay afloat in foreign and domestic politics, to crow to the entire world about the superiority of our socialist system and even to declare "solemnly": "The current generation of Soviet people will live under communism." Now Krushchev's admirers do not want to recall this.

Korolev's last efforts with the notation "world's first" (the pursuit of publicity firsts, naturally, was not Sergey Pavlovich's style) were the launching of the **world's first** woman cosmonaut (although she was not the 1st person in space, but rather... the 12th), the launching of the **world's first** multi-seat ship, the Voskhod (although, in essence, this was the same Vostok ship, but Korolev had managed to seat 3 cosmonauts in it) and the **world's first** egress of a cosmonaut into open space (the space stunt when a cosmonaut connected to the ship by a special line, in regular fashion, leaped out of the ship for several minutes and then, using the line, returned to the ship). These flights produced practically nothing new for science.

The last two flights had already occurred during the time of Brezhnev's government. The special feature of these last flights was the fact that there was no longer any quality in them.

But, at that time, there appeared in the Americans' arsenal a whole class of launch vehicles capable of inserting into space space vehicles for various purposes and with varying masses. Liquid hydrogen appeared in the "armament" of their launch vehicles as a new fuel. There appeared also powerful solid-propellant rocket engines and other innovations. And our qualitative lag behind the Americans was beginning to show. Our leaders either did not see this or did not want to see this. In 1962, in the USA, the first liquid-hydrogen rocket was launched. This, perhaps, also settled the question of who would reach the moon first.

Yet, indeed, there was a whole troop of curators in the Central Committee: V.A. Popov, the instructor of the

defense department, B.A. Stroganov, the sector head, and I.D. Serbin, the department head. Were they not the ones directly responsible for our country's lag in the space program? But the chief curator of our "maneuvers" in space was Central Committee Secretary D.F. Ustinov. He also reported to the members of Brezhnev's Politburo that "everything is fine" in our space program. All of them no longer hold their positions, but, indeed, things are no easier for the space program because of this.

A certain reanimation in the space program ensued in 1965, when the country received a rocket more powerful than the R-7, the Proton launch vehicle, although, even using it to solve a key problem—sending a man to the moon, about which our newspapers grumbled—was impossible.

The crisis in the Soviet space program grew ever larger. And it was not the people who were at fault, but rather, the leaders who headed up this matter. Korolev died in January of 1966. Russia no longer had another person like him. His successor, V.P. Mishin, who tried to continue the developments begun by Korolev, was soon replaced by a favorite of Brezhnev—V.P. Glushko, who also "finished off" the work begun so successfully. Yes, the very same Glushko who, back in 1930, wrote denunciations to the NKVD [secret police] about his more talented associates, including Korolev. A Glushko personality cult began in cosmonautics. History began to be recarved according to his personal discretion. He "went so far as" to write books on the history of rocket technology, where, after K.E. Tsiolkovskiy, of course, it was he, Glushko, who stood in first place.

The storming of space begun by the Americans in the second half of the sixties showed that we lagged hopelessly behind and this lag began to grow ever larger as the years passed. The newspapers, of course, continued to sound off about the superiority of the Soviet space program over the American space program and about certain "new steps" in the exploration of space. The editor of the Mashinostroyeniye Publishing House, Lev Abramovich Gilberg, having tasted the profitability of publishing books on space, even came out with a photo album called "The Exploration of Space," which, for some reason, began to be called a "scientific work." After the first edition in 1969, this album began to be republished periodically, but now with other titles: "The Soviet Space Program," "The Space Program in the USSR" and so on.

The TASS reports, which were far from the truth, were prepared by a specially established group headed up by Professor Yu. A. Mozzhorin, who had tried unsuccessfully 13 times to break into the ranks of the academicians. They reassured the average citizens with imaginary successes in the field of cosmonautics. Gilberg, in order to push through his own feeble books, included associates of Mozzhorin's group and Mozzhorin himself as authors, author compilers and editors. Warming their hands in the "space" field were all those who stood at this trough, including also those who made a career of this sector of science and technology.

The task of Mozzhorin's group consisted of misinforming the public and concealing from the people the blunders and the real state of our affairs in space. But the deception became obvious when, on 21 July, 1969, the American civilian pilot, Neal Armstrong, became the first earthling to set foot on the surface of the moon and planted the American flag. Our deceitful propaganda, supervised then by M.A. Suslov (now one of Moscow's boulevards has been named after him), was forced to show this historical event on our television screens in the end, when a volleyball match between two local teams was relayed.

We responded to the Americans' triumphal flight to the moon with the flight of three Soyuz ships in October of 1969. The adventurism was revealed by the fact that two ships did not dock and even the welding experiment, which was supposed to be carried out on one of the ships, ended unsuccessfully. They almost burned a hole in the ship. The ships and their crews (the "Magnificent Seven") returned to the ground. The order came from the Kremlin to award all of them with Stars of Heroes of the Soviet Union. And since they were all heroes, this means that the flight also was "heroic" and "successful." TASS reported this to us. That same Mozzhorin prepared the TASS report.

State secrets, undoubtedly, must be safeguarded, but here it was necessary to keep a lie a secret. So deception was begun in our country not only about milk, but even in space. And this deception originated not with Stalin, but rather, with Krushchev's period, which the current "foremen" of perestroyka like Fedor Burlatskiy (Khrushchev's assistant at the time) are calling the period of "thawing."

The American have sent their space ships to the moon 9 times, 12 Americans have walked and ridden in a motor vehicle across the moon and 24 have had a bird's-eye view of the moon. But we continued to "roll" along the well-traveled near-earth orbits, the way along which was paved by Yu.A. Gagarin. We proved to be incapable of going outside Mother Earth's attraction zone.

Then the Americans confidently passed us in the development of an orbital station with replaceable crews. Our experiment in replacing crews ended in failure: the Soyuz-10's crew, with incredible difficulty, managed to undock from the Salyut orbital station, after not being able to transfer to it, while the Soyuz-11's crew, not having replaced anybody, perished after undocking during the return to the ground. After some time, we continued the "storming" of space, sending up to the Salyut station one new crew after another, who simply sat tight in it, setting records for the length of a stay at an altitude of 200-300 kilometers. The number of orbital revolutions were multiplied by the length of an orbital revolution, resulting in the world's longest "road in space." We were very proud of this: look, we said, at how

long we are flying and how far we are traveling... without leaving the one and the same road. Neither to the right nor to the left.

After the flight of the American Skylab orbital station, they had a small break in flights. And then came the year 1981. On 12 April, Cosmonautics Day, the Americans celebrated a new triumph. The world's first reusable space transport ship, Columbia, flew with two astronauts on board. The imagination of many specialists was startled by the fact that the first test flight, on the first try, as they say, was a success! World cosmonautics had never known such a thing. But what about us?

We continued with unprecedented obstinacy to sound off about the Soviet space program's "new steps," but we no longer talked about the Americans' lag, reporting through clenched teeth about the American astronauts' triumphal flights. The fresh, young smiles of the Soviet contingent of cosmonauts, from which wafted indeed the smell of romance, were replaced by the strained propaganda shows, which became increasingly more absurd.

In order to show the world that we were still capable of something, that we still had some pocket change and in order to continue to squander it "handsomely," we began to "send" on excursions into space citizens from the Warsaw block countries and later went on to "send" cosmonauts from developing countries. Why? For the sake of "preserving peace on earth," as we wrote. And, as is widely known, the main champion in this matter was, of course, Leonid Ilich Brezhnev. He, a native Russian, grabbed from Khrushchev the baton of paternity of the cosmonauts.

The award ceremonies and the bombastic dispatches on the occasion of these flights, which were of low quality in all respects, roared out on the television screens. Our cosmonaut contingent grew quantitatively, but not qualitatively. Apparently, the "stagnation" also had a telling effect on the cosmonauts' training. And the cosmonauts' training was the concern of a great friend of Lev Abramovich Gilberg—General V.A. Shatalov. Gilberg published a few books, some under the editorship of Shatalov and some authored by a friend of Shatalov—Colonel M.F. Rebrov. Mozzhorin's group joined them.

At first, the number of Heroes of the Soviet Union increased, then the number of Twice Heroes and then the cosmonaut-generals.

As if from a cornucopia, there showered down upon the heads of all the members of Brezhnev's Politburo gold stars and medals. There was a second round of this and there appeared in the Politburo their own "generals": Twice, Thrice, Four-Time and Five-Time Heroes. And the medals already received by each of them simply could not be counted. Ustinov outdid them all (11 Orders of Lenin). After him came bribe-taker Rashidov (9 Orders of Lenin), then came Kunayev, Leonid Ilich himself, Gromyko, Solomentsev, and Aliyev (8 Orders of Lenin each). Against this background of "generals" of the peaceful time of "stagnation and graft," the Liberator of Russia, G.K. Zhukov, looked pale by comparison, he only had six Orders of Lenin! And these were for the Civil War, for the battles at Khalkhin-Golo, for the defense of Moscow, for Stalingrad, for the battle at the Orel-Kursk Bulge, and for the taking of Berlin. What a shame!..

What tells of the kind of orgy which broke out on the fields of peaceful, post-war Russia with awards and titles is the fact that our famous designer, S.P. Korolev, for unquestionably outstanding services to the Homeland, for the development of the first intercontinental ballistic missile, for the first satellite and for Gagarin was awarded in all two Orders of Lenin and the Badge of Honor.

Brezhnev's circle continued to burn plenty of the people's money in space for the sake of their own political ambitions. The deception flourished with ever greater strength. The peasants bent their backs in the country's fields and the workers at their machine tools and open-hearth furnaces, competed for the titles of "Our Beacons" and "Shock Workers of the 5-Year Plan," receiving beggars' wages and the badges of "Shock Workers of Communist Labor." Those who were older, at times looking back, fearing the liberal terror of different kinds of rascals, loafers and outright traitors to the Homeland, yearned for previous times.

There was applause when the matter arose about the publication of the collective labor of our scientists—the Encyclopedia of Cosmonautics, which was supposed to illuminate all the achievements of world cosmonautics, and there came to the surface an entire galaxy of heroes of the "invisible front"—those who prepared for the leadership information about the state of our space program and those who lived over the course of many years off this profitable sector, which was not controlled by anyone.

Memorable to me are the words spoken at one time by U.S. President John Kennedy: "Whoever possesses space, possesses the world." We did not truly possess space. The people still do not know why, year after year, regardless of the depth of the economic crisis, rockets are being launched with cosmonauts and what our cosmonauts are "achieving" in space.

For the first time, V.G. Afanasyev, former chief editor of the newspaper PRAVDA, broached this "closed-to-criticism space area" in his speech at the next congress of the USSR Union of Journalists. He said then: "...The departments responsible for space have gotten it in their heads that there is always and in all things order in their eparchy, that 'everything is proceeding normally.' But, without a stamp of approval from these departments, the press cannot say anything which is objectionable to them. An anachronism? Yes!"

"In clamping an iron claw on publication with the invariable stamp 'everything is in order.' these departments are depriving the press, and along with it its

readers, our people, as well, of information about how dangerous and heroic the cosmonauts' work is..." (PRAVDA, 14 March, 1987).

But V.G. Afanasyev did not name the specific persons who "are clamping the iron claw on publication" and state what kind of damage is occurring because of this.

The revealing story of the publication of the Encyclopedia of Cosmonautics merits a brief presentation. The encyclopedia was supposed to be published in 1982. It was prepared over many years by a large collective of authors (around 300 persons), among whom were 14 academicians and corresponding members of the USSR Academy of Sciences, more than 100 doctors of science and cosmonauts. Scientists from all the socialist countries participated in the book's preparations, as did a number of capitalist states as well. In one word—a force!

Prior to the manuscript being set to type, the book's sections were approved and stamped in the appropriate pertinent departments as the appropriate instructions required. At the stage when the book is signed to press, it was given to the chief "propagandist for the space program," Professor Yu.A. Mozzhorin, who, because of his own incompetence (well, one person cannot know everything!) held on to the book for 5 months and then for 2 more years! As it turned out later, he was looking for sedition. And he found it: the book, he said, has been written on a low scientific level and popularizes Western achievements. It turned out that, without the stamp of approval from this bureaucrat, not a single book can see the light of day. Even an encyclopedia.

On 31 August, 1982, a group of most prominent Soviet scientists, headed up by Academician A.Yu. Ishlinskiy, sent a letter to the CPSU Central Committee, to M.V. Zimyanin (the then Central Committee Secretary for Ideology) with a request that he accelerate the matter with the signing of the Encyclopedia of Cosmonautics to press. The scientist wrote straight out that the motives for delaying the scientists' fundamental work were "not sufficiently serious and the non-publication of the book will inflict great harm on our country." The letter, addressed to Zimyanin, fell into Mozzhorin's hands, who also responded to Zimyanin, having managed to get the response signed by his own minister, S.A. Afanasyev, the president of the USSR Academy of Sciences, A.P. Aleksandrov, and so on. High-ranking state figures were drawn into the orbit of deception.

A number of scientists (Academician A.F. Bogomolov, Doctor of Physical and Mathematical Sciences M.L. Lidov and others) sent letters to the magazine KOMMUNIST, in which it was asked: "How could it come about that the work of several years by an enormous collective of highly qualified authors could turn out to be under the threat of being compromised by a capricious stroke of the pen of several associates?"

At the beginning of December, 1982, a large group of authors (around 100 persons) sent a collective letter addressed to Yu.V. Andropov. On 4 March, 1983, the author of these lines, as the executive secretary of the encyclopedia, sent a detailed letter about the outrageous red tape to the magazine KOMMUNIST. The magazine's chief editor, in turn, along with his own cover letter, which noted the irregularity of the situation surrounding the Encyclopedia of Cosmonautics, sent this document to Deputy Chairman of the USSR Council of Ministers L.V. Smirnov (now former deputy chairman). The number of officials drawn into the bureaucratic carousel began to grow.

It seemed that the matter would finally be settled. But the system was such that even the Deputy Chairman of the USSR Council of Ministers could not settle this matter.

At this time, Mozzhorin was preparing yet another biased finding about the harmfulness of the publication (of course, he was not among the authors or on the editorial staff), with false statements. For his finding, he managed to obtain the stamps of approval from responsible state figures. But even this was not enough for him—he re-did the letter, made a xerox copy and passed it off as the collective opinion of five departments. The original mysteriously disappeared, while the xerox copy of the false letter was sent by Mozzhorin to the editorial office of the magazine KOMMUNIST as the "response" of the Deputy Chairman of the USSR Council of Ministers. This is how it is necessary to work under the conditions of "democratic" paralysis!

The letter was submitted for examination to the USSR Ministry of Justice's Judicial Examinations Institute. The response from there was: the letter has all the signs of a forgery. The matter of the book's publication began to move forward. KOMMUNIST's chief editor sent the document to the CPSU Central Committee's Party Control Committee, to I.S. Gustov, and the book soon appeared. But with significant cuts, which the still omnipotent Mozzhorin had managed to make. Is there justice for this person, who once worked and is working again as a director of a sectorial institute of the Ministry of General Machine Building? No! The "space mafia" is supporting him.

The authors of the Encyclopedia of Cosmonautics decided to expose this using the following simple method. Seventeen people signed a complaint to the Moscow City Executive Committee's GUVD [Main Administration of Internal Affairs] so that it would investigate the official forgery, in which, in their opinion, high-ranking officials had participated and whose actions led to the discarding of a book ready for typesetting and the inflicting of harm on the state. But, despite repeated reminders, the authors have not even received a reply (even though quite a bit of time has elapsed since 17 December, 1985).

But the affairs in the space program continue to remain deplorable. The ravaging of the space program has

occurred in all directions, both in the field of the manned space program and in the field of automatic means for investigating outer space.

Still mining the space program from below (following the policy of the Mashinostroyeniye Publishing House), like a gold vein, is Lev Abramovich Gilberg, who is publishing expensive photo albums with an "icon-painting" of the cosmonauts, which no one needs any longer (incidentally, KNIZHNOYE OBOZRENIYE [Book Review] has already written about this). Gilberg's collective of authors is illustrious—a couple of ministers and deputy ministers and Central Committee and Council of Ministers staff workers, to whom he was "compelled" to pay astronomically high royalties.

Then there is one more layer which has "made a living off" the space program—the so-called "consultants" from TASS, some of them with a "fisherman's" and "nursery-worker's" education, from the same circle as Gilberg. Affiliated with this layer are the corresponding "space" legions from Interkosmos, Glavkosmos, Intersputnik, Star City with its cosmonaut contingent and so on.

A similar network, which has set up a lifelong money pipeline from the state budget into its own pocket, has been established in the USSR Academy of Sciences' system. A striking representative of this system is the now former director of the Space Research Institute (1973-1988), Roald Zinnurovich Sagdeyev.

Sagdeyev has been a participant in many of the experiments on our space program. His achievements in the space field are zeros. How many space vehicles "perished" in space, simply because they were launched untested, "raw"! And no responsibility whatsoever. For irresponsible scientific leadership, the Gold Star of a Hero of Socialist Labor gleams on Sagdeyev's chest. His last "achievement" in space was the loss of the two Fobos craft launched to Mars, the cost of each of which was 400 million rubles. This is without counting the cost of the two Proton launch vehicles and the cost of the launching.

Recently, Sagdeyev's name has again thundered throughout the world. The American news agencies reported to our blue-collar and white-collar workers the joyous news: Sagdeyev is marrying the granddaughter of former U.S. President D. Eisenhower—Susan Eisenhower. "Permission" has been received from Ye.M. Primakov—on the face of the latter upon receipt of the "supranational" news "something like delight appeared" (Sagdeyev's own words, THE NEW YORK TIMES, 6 January, 1990).

THE NEW YORK TIMES reported that Sagdeyev heads up the theoretical center of the Space Research Institute and that he "left the post of director of the institute in 1988 after profound criticism directed at the bureacracy which, in his words, is smothering Soviet science." Is it not just the opposite? Was it not Sagdeyev and his patrons in the person of the former vice president of the USSR Academy of Sciences and the chairman of Interkosmos, V.A. Kotelnikov, who smothered and are smothering Soviet science?

The space program is just as ownerless as Russia. Now, having looted the Soviet space program, established by the efforts of Korolev and a galaxy of outstanding Russian scientists, one of its leaders, Sagdeyev, having proven to be incompetent, is paddling under Washington's wing. Perhaps there, on American soil, he will show his worth to the proper extent, better than in "bureaucratic" Russia, where our bureaucrats "smothered" him? Along with Sagdeyev, will not our secrets also travel over the ocean? The deal went through. But what about the deputy's seat? Or now, as a person with dual citizenship, will he also represent America in the USSR Supreme Soviet?

Sagdeyev, together with Sakharov, participated in political games with the West, being one of the members of the "Fund for the Survival and Development of Humanity," to which, incidentally, Academician T.I. Zaslavskaya also belongs. The only thing that is not clear is the kind of humanity for whose survival they are pleading.

A large blow was inflicted on our space program by Ustinov's group back in 1974. Academician V.P. Mishin (Korolev's successor), the chief designer removed from his position, was replaced by Academician V.P. Glushko. Retaining his former seat as chief engine designer, he became simultaneously both the general designer and the director of the scientific production association (NPO), which was established by the merger of two OKB's [Experimental Design Bureaus] in order to satisfy the whim of the newly appointed head of the Soviet manned space program.

As subsequent practice has shown, except for the numerous well-paid seats, the establishment of the NPO did not yield anything. The damage done to the matter was immense. Whereas there previously existed at least some kinds of alternative opinions about the development of the Soviet space program, now the entire decision-making process was concentrated in the hands of an aging and ambitious "pioneer" of the space program, who did not tolerate even a hint of a viewpoint which differed from his own.

Having been for many years the chairman of the Council on the Rocket Fuel Problem of the Academy of Sciences' Presidium, Academician Glushko did his utmost to hinder the introduction into Soviet space technology of the oxygen oxidizer and hydrogen fuel, the promising aspects of which K.E. Tsiolkovskiy had shown back in 1903.

Beginning with 1963, American rockets using an oxygen-hydrogen fuel flew in near-earth orbits and to the planets and it was thanks to this fuel that the Americans landed on the moon. Oxygen and hydrogen had been successfully used by the Western Europeans, the Japanese and

the Chinese, but Glushko stubbornly continued to reiterate that "oxygen is by far not the best oxidizer, while hydrogen is simply not suitable for practical application purposes" and "has no future as a fuel."

There were, of course, scientists and designers in our country, who did not agree with these "revelations," which had been published in a book by Glushko back in 1935. For example, Academician A.M. Lyulka, on his own responsibility, developed in the sixties and organized the production of a rocket engine which used an oxygen-hydrogen fuel. But the bureaucrats from the Ministry of General Machine Building did not give him a chance: how dare Lyulka, an aviation specialist, intrude into the eparchy of another department! Thus, along with the fuel burned during the testing, tens of millions of rubles went down the drain.

Meanwhile, after the successful completion of the lunar program, the American space program got ready for a new jump forward. Space-based production, which, up till now, basically just raised some smiles, was to be placed on a commercial basis henceforth in the USA. In order to make the space program profitable, it was necessary to develop ships and launch vehicles which can be used repeatedly. For this purpose, the Americans set about at the beginning of the seventies to implement the Space Shuttle Program.

Heading up the Soviet space program, Glushko decided to meet the American "challenge" with his own space program. It was supposed to be a match for the time of the great construction projects and recarving of the planet's geographical appearance. And Academician Glushko, who soon became a member of the Central Committee with Ustinov's help and a deputy of the USSR Supreme Soviet, submitted for the approval of General Secretary L.I. Brezhnev a fantastic project for the development of an inhabitable base on the moon, at a cost then of "only" 100 billion rubles. But this impressive sum was capable of sobering up even Brezhnev who vetoed the latest "project of the century." And then Glushko and a detachment of bureaucrats from the Ministry of General Machine Building and the Central Committee threw themselves into pursuit of the American space shuttle. But to duplicate on a one-to-one basis the finished project of another would be unseemly, especially since the powerful solid-propellant engines (which had also been kept in the background in our country for many years thanks to Glushko) turned out to be beyond the capabilities of the Ministry of General Machine Building's enterprises to make.

And so the two such engines on the American shuttle were replaced by four liquid, oxygen-kerosene (!) ones and the Space Shuttle was converted into the Soviet Buran space shuttle. The developers of this "original" project were not troubled by the fact that the development of a liquid rocket engine with a thrust of just under a thousand tons would cost billions of rubles. On the other hand, it would be the most powerful engine in the world!

In order to make the project even more "original," Glushko decided to make an engine with not a single combustion chamber, like the Americans had, but rather, with four chambers: this may be more complicated and expensive, but, on the other hand, nobody else in the world was doing this. But even with this, the whims of the latter-day father of the Soviet space program did not come to an end: he decided to "boost" the pressure in the fuel pumps of his engine to 1,000 atmospheres!

In order to get this monster to work, tens of thousands of talented scientists, designers, workers and testers would be compelled to spend 15 years of their lives. And so, tens of billions of the people's rubles were spent on piles of scorched and twisted metal, whole trainloads of valuable fuel were burned, the ground around the test sites was contaminated and the atmosphere was poisoned and still Buran cannot master space.

Three general secretaries have yielded their power and gone on to the world beyond and Glushko had promised to each of them that they would see his brainchild in flight. But, finally, even he gave out and took to his bed, broken by the insult. "What are we to do?" the bureaucrats "from the space program" asked one another: their seats were crumbling under them, for the American Space Shuttle has been operating for 10 years now!

And then they decided to pull the wool over the people's eyes by "surpassing" the Americans and sending Buran up without a person, on automatic, passing this off as the latest remarkable achievement of the Soviet space program. The misleading TASS report was prepared again by that same Mozzhorin who has been continuing to safeguard the interests of his department since Khrushchev's time.

The venture was a complete success and so, again (for the umpteenth time!), those "elect" who plundered the country, having scattered its riches to the four winds, divided among themselves the rich spoils. Glushko's deputy for engine matters, V.P. Radovskiy, in a brief span of time, became a Hero of Socialist Labor and a recipient of the State and Lenin prizes and stepped out of the ranks of the candidates of science right into the ranks of the corresponding members of the USSR Academy of Sciences. Glushko and the Ministry of General Machine Building "hammered out" this "vacant position" for him in the Academy of Sciences "by special appointment" (And such a thing does happen in our country!). Without election...

But there has still not been a decision about putting a person on Buran: Glushko died (for a whole year, he, stricken with paralysis, was listed as the acting head of the Soviet space program!). In order to sign documents, they made him a signature stamp, but, up till now, no one has wanted to take the responsibility for it. Even in the Ministry of General Machine Building, not a single minister has been replaced.

They are trying to talk more and more quietly about the Energiya superrocket (named after the as-yet-unrealized NPO) with the engines from Buran. It is also not flying and, in fact, they even forgot in their haste to think about what to convey into space on it; there are no payloads for it. They nearly decided to abandon the unneeded Energiya to the Americans: to accommodate it under a joint Mars project. But wealthy America does not have an extra 100 billion dollars for this. And besides, what do we need with your non-flying Energiya, said the American specialists, when, 20 years ago, we produced our own Saturn-5 rocket, which is more powerful than Energiya by 30 percent (it can carry into space 130 tons, while ours, according to the press reports, can carry only 100 tons!).

The chief scientist of the Space Research Institute, K. Gringauz, in the article "The Loss of Escape Velocity" (PRAVDA, 25 March, 1989) declared that, "If these resources had been allocated to the Academy of Sciences (and not to the Ministry of General Machine Building, evidently—German Nazarov) and if Glavkosmos' design bureaus had had a financial interest in filling the order, then the technical level of the Soviet space vehicles and their testing on the ground, undoubtedly, would have risen." But really, have so few resources been allocated to the Academy of Sciences?

In 1989, 6.9 billion rubles (according to the reports of our press) were spent for all the space programs. Taking exception to LITERATURNAYA GAZETA correspondent O. Moroz, who exclaimed that this was a "colossal figure," A.I. Dunayev (the same person, about whom a complaint was sent to the Moscow City Executive Committee's GUVD), the head of Glavkosmos, responded: "We are spending very little on space: in the current year, 1.7 billion rubles for national economy and scientific tasks and 1.3 billion rubles for the reusable Buran space system. So, what is this about 6.9 billion rubles (this figure, I assure you, is reliable)?!" (LITERATURNAYA GAZETA, 20 December, 1989).

But further on, Dunayev "reflected" on the losses in our agriculture. These arguments, in Dunayev's opinion, justify also the loss of these 6.9 billion in space. We are just losing too little, so Dunayev figures, and this is why the figure of 6.9 billion—the figure for the losses and not for the profit—is quite sufficient for them to be burned in space.

Perhaps it is time to begin a people's movement for banning the burning of money in space, similar to the movement against the "diverting of the rivers"? Indeed, even for this "project of the century," no one paid the penalty. But someone ought to! It is high time to demand this!

From the editor's office. We do not fully share the point of view of the author of the polemic notes; we do not believe that the efficiency of modern space research is close to the zero point as would seem to follow from G. Nazarov's article. We have no doubts about the contribution of specific executors (workers, engineers and scientists) and the selfless labor of the cosmonauts. But the research strategy itself and the research concept merit a great deal of attention and serious discussion—especially since the opinion about the harmfulness of the strategic policy as a whole has become so widespread. This is also understandable: the triumphant dispatches about "cosmic" [in the sense of "space"] successes with cosmic (without quotes) [in the sense of "colossal"] expenditures sound alarming against the background of the worsening economic crisis.

Footnote:

G. Nazarov is familiar to our readers from his works on Soviet history themes, which were published last year by MOLODAYA GVARDIYA in issues No 10 and No 11 ("Ya.M. Sverdlov—an Organizer of the Civil War and of Mass Repressions" and "The Shock"). For more than 30 years, he has been involved with matters relating to the space program, as a specialist in the field of rocket technology and, later on, as a scientific consultant for TASS and BSE [the Large Soviet Encyclopedia] on space program matters. He is the author of many articles on this theme in the BSE and is the executive secretary of the Encyclopedia of Cosmonautics (1985). For his achievements in the field of cosmonautics, he has been awarded the Gold Medal imeni S.P. Korolev and the Medal imeni Yu.A. Gagarin.

Flaws in National Space Policy Criticized

907Q0068A Moscow IZVESTIYA in Russian
5 Apr 90 First Edition p 3

[Article by V. Postyshev, candidate of legal sciences and member of the International Institute of Space Law: "Hostages to Achievements. Why There Is no Unified Concept in the Country for Space Research"]

[Text] It is not by chance that during the years of perestroyka cosmonautics has been subjected to sharp criticism. Grandiose space projects combine poorly with the general shortage of top priority essential goods, and the definite prosperity of Zvezdnyy Gorodok with the lack of elementary order in production, transport, public health, education, services, and so forth.

Even more serious arguments are put forward. Academician R. Sagdeyev, for example, writes that we have not found an optimal relationship between manned and unmanned space research. In his unique monograph "The Soviet Space Program" the American expert R. (Hamble) notes the mismatch between basic and applied space research in the USSR. Lenin Prize laureate V. Istomin reveals defects within space science itself, in particular voluntarism in the selection of its priority directions. Cosmonaut B. Yegorov suggests that it is not possible to gain any quick return from industry in space in the near future. "Space research has maintained its monopoly of secrecy, nepotism, and political intrigue," is what Academician V. Mishin thinks.

So what is happening in space research in the USSR? Why have we so many times been the hostages of our own achievements?

The first thing that becomes obvious even from a superficial look at the state of affairs is the catastrophic imbalance of social interests focused in space research.

Thus, according to UN figures more than 75 percent of the USSR space budget is military. Could it be, perhaps, that this is why we have not very often encountered space research "products" in everyday life?

Almost 20 years ago the idea was put forward of trading services for launches of space vehicles in order to obtain a hard currency return. It was turned down on the pretext of keeping state secrets. In 1985 the Soviet Union nevertheless did go into the international space market with an entire series of launch vehicles. But time had been lost, and with it the favorable market situation. In the early seventies we would have been able to secure a monopoly in this direction. Now the United States, France, China, and India all have their own highly economical launch vehicles. It is difficult to compete with them.

The question of developing the INTELSAT global commercial satellite communications system had been raised even earlier. The USSR went on to set up an alternative organization. The end result was that INTELSAT was joined by more than 120 countries, and INTERSPUTNIK by 14. The American Comsat company, which plays a key role in INTELSAT, is obtaining considerable income, but we hear no reports about the activity of INTERSPUTNIK. Here, economic interest fell victim to foreign policy interests, which now of course have been fundamentally revised.

From the mid-seventies the USSR has been actively cooperating with the CEMA countries in the field of studying earth from space. Corresponding work is being done under the aegis of the State Committee for Science and Technology and is of a primarily scientific nature. The growing trend toward commercialization of this kind of applied space research has remained out of the line of vision. As a result, last year Hungary gave the French company "Spot Image" the right to trade satellite pictures in its own domestic market. Other East European states are orienting themselves increasingly toward Western sources for space information. It is even worse because in 1978 at the initiative of the USSR a convention on remote monitoring of Earth was signed, establishing restrictions on the use of information obtained from satellites. It is now being used as grounds for claims being made against the Soviet Union.

Another example. In 1987 the USSR Ministry of Foreign Affairs offered an initiative on setting up a world space organization. The main purpose of this step was to oppose the American SDI program. In order to secure international support, the corresponding draft laid emphasis on the needs of developing countries in the field of space research. But setting up new intergovernmental structures and help for the developing countries need money. Who has calculated the cost of this kind of diplomacy, and whether it can be realized in practice?

Unfortunately,it would be easy to continue with this list. Moreover, a close look reveals that the goals of Soviet space research are being set without comprehensive or—the most important thing—objective grounds. One is convinced of this particularly when comparing it with other countries' space programs. Thus, nowhere in the world is so much attention given to putting cosmonauts into space. But a manned mission is 10 times more costly than an unmanned mission per kilogram of payload. Here, more than 90 percent of scientific and practical tasks and virtually 100 percent of national economic tasks can be resolved with unmanned vehicles.

No one now sets as a goal in and of itself that of increasing the power of launch vehicles. In the United States a booster vehicle that is superior to our "Energiya" in terms of this indicator was developed as long ago as the late sixties. After it had served its purpose (missions to the Moon and lofting the "Skylab" into orbit) it was withdrawn from production and no longer used. Japan immediately set aside the construction of heavy rockets, placing the emphasis on lighter-weight satellites through technological improvements and microminiaturization in radioelectronics. The result: the Soviet "Gorizont" satellite weighs more than two tons and offers eight communications channels, while in Japan work is being completed on a satellite weighing about 30 kilograms with 35 communications channels.

Abroad, the lion's share of the space budget goes to develop the ground infrastructure. Again in Japan they have started to produce cars equipped with satellite navigation and communications systems. We have nothing like that. The end user—industrial and agricultural enterprises, fishing fleets, geological survey parties, and transport—do not have operational access to space facilities. Space research is divorced from the general economic mechanism and in most cases does not offer any economic saving.

The present feature of world space research is the extensive use of space technology to resolve problems on Earth, including production of consumer goods. In the United States this is ensured by a quite complex organizational-legal mechanism that prevents monopolization of the achievements of space science and technology even by powerful departments like the Pentagon. Here, we have only just started this work, and not very well either. In the USSR conversion is understood in a vulgar way, as a reorienting of existing production facilities to produce consumer goods, and in practice amounts only to reducing allocations for the defense sectors. Under the conditions of an inadequate market for hi-tech output, the latter find themselves in a complex financial situation and are losing highly skilled personnel, and are at the verge of the start of an uncontrollable process of degradation.

Finally, foreign space programs are deeply pragmatic and calculated down to the last detail. But we are developing an obsolete version of the American "Shuttle" for which there are no payloads in the coming decades. It is even more amazing that among the 13 priority directions in the state scientific and technical program confirmed in 1989, all the polemic about space research notwithstanding, only one space project is mentioned, namely a Mars mission.

Mention should also be made of the "aggressive" foreign economic policy of the Western states in the field of space research. International cooperation in the field of space research under the aegis of the United States has been built totally on economic considerations. Some NASA projects are being financed 70 percent or more by their foreign participants. Here we have an exactly opposite picture. The "Intercosmos" program is based on the principle of absence of mutual accounts, which is leading to a situation in which the USSR provides the launch equipment while other participants provide particular instruments, which cannot be compared in cost terms. The decision to bring Soviet space research into the international space market without an adequate organizational mechanism, legal guarantees, and qualified personnel hides another danger, namely, a drain of high technologies, which in the era of the scientific and technical revolution constitute a very important factor in the might of any state.

The impression is being created that in the USSR there is no single concept for space exploration that would be strictly adhered to in the practical activity of departments and organizations in the space complex. It is not known who is responsible for the realization or derangement of any particular space project. Consideration of costs in realizing a project is very weak. There is no feedback or evaluation of final results. Managerial stupidity is what this disease is called. Neither is there any hint here of more or less well-considered managerial decisionmaking or competent realization of decisions. The now fundamental chain—goal-means-result-feedback-and so forth—is not considered.

The management of space science and industry in the USSR has been set up in a largely random manner. The logic of the space race, to which we were initially attracted with an enthusiasm that could better have been applied elsewhere, increasingly raised new questions. These questions were thrown out to the departments, and inside the departments space main administrations and subdivisions proliferated. Later the process acquired the nature of some end in and of itself. The space firms themselves started to set their own goals, and after they had received funding, to do the corresponding work without any proper state, or even less public, control. The numerous coordinating organs changed nothing because they are all representative and interdepartmental in nature and have no serious powers. Neither can we ask very much of Glavkosmos since it is merely part of a single department—the Ministry of General Machine Building.

Strictly speaking, this kind of management is not a system. Departmental dissociation and the monopoly of each department over its own little piece of space research are combined in an impossible fashion. The monstrous hybrid of departmentalism and monopolism in the management of Soviet space research also leads to the economic, political, and moral losses that have transformed it from the subject of deserving pride by Soviet people into a soup kitchen.

Whence stems logically the idea of centralizing the space activity conducted in the USSR within the framework of some special agency, as expressed in particular by V. Shatalov in IZVESTIYA. This idea, however, is at variance with the trend toward decentralization in management of the scientific and technical complex in the USSR. Consequently, the real task is to find an optimal relationship between centralism and decentralization in management, and to create flexible management structures that would not be "blocked out" by either side.

In world practice we do have an example of a flexible system to manage space activity, aimed in each case at establishing a balance between various kinds of public interests. Thus, in the United States the main government organ responsible for the civilian sector of space research is NASA, which carries out its functions by placing orders for particular work and manufacture of the necessary equipment and apparatus to private and government firms, universities, and research centers. Here these same scientific, production, commercial, and noncommercial institutions may fulfill orders for another key American space organ within the system, namely the Department of Defense. There is a coordinating committee for NASA and the Department of Defense, and at a higher level there is the National Space Council led by the U.S. vice president. The main directions of space policy, including funding for space programs, are discussed and confirmed by the Congress.

In the Soviet Union there is no need to copy the quite complicated American system for managing space research, which includes about 30 structural subdivisions. Obviously this is impossible both because of financial considerations and the difficulties that inevitably arise when existing management structures are disbanded and their powers transferred elsewhere. However, we can and must take basic steps that would gradually bring Soviet space research to a qualitatively new level. It is important to define clearly the powers of the USSR Supreme Soviet and Council of Ministers in the sphere of space research management. Establishing the principles and goals of Soviet space policy should be assigned to the competence of the Supreme Soviet, and naturally, confirmation of the space budget and of major space programs will require the creation of a sufficiently expert service. As the highest executive and administrative organ the Council of Ministers should be responsible for the implementation of space policy, taking steps of an organizational, material-technical, and financial nature to this end.

It is necessary to set up a state space concern—a voluntary association of interested scientific and production enterprises of various departmental subordination. It would seem that the concern should not infringe on the competence of organizations operating in the sphere of space research. Its main goal would be to coordinate, create and handle financial reserves, and provide expert assistance and legal support in the international space market. The concern should be based on cost accounting, and after creation of the initial capital should switch to self-financing.

Of course, work on space legislation also cannot wait. All the measures proposed above should be formulated legally. At this time we do not have a single open legislative enactment that regulates space activity, unless we count the 1961-1962 ukases of the Supreme Soviet Presidium on introducing "Cosmonaut Day" and the title "Pilot-Cosmonaut of the USSR" and the corresponding medal. In the United States the first law on space was passed in 1958. American space legislation is now numbered in the thousands of pages. Presidential directives on national space policy are extremely authoritative. Effective regulation of space activity carried out in the Soviet Union, and protection of the foreign economic interests of Soviet space firms, require first and foremost a USSR law on space policy and a USSR law on commercial space activity.

The institution of presidential power recently introduced in the USSR can play an important role in the restructuring of Soviet space research. Now is the time for advancing a new space policy for the USSR that would on the one hand be understandable by the broad strata of the population and on the other hand would meet the highest scientific criteria. Squandering the potential of so much work done by the vanguard directions of the scientific and technical revolution will be fatal.

Voronezh Space Facility 'Khimavtomatika' Declassified

907Q0101A Moscow PRAVDA in Russian
21 May 90 1st edition p 2

[Article by PRAVDA correspondent V. Stepnov: "It Is Not Only Flames That Fly Out From a Rocket Nozzle"]

[Text] **Many people feel a certain irritation at the delays in conversion. Why, they ask, are the defense guys procrastinating; why do they not wish to use their immense scientific and technical potential for the good of the people? Very few of these people understand that conversion requires a lot of energy and expense and if you treat it with only the momentary advantages, in mind then it might become just another campaign.**

The "Khimavtomatika" design office must be the most prestigious institution in Voronezh. In spite of the thick shroud of secrecy enveloping it, the people of the city suspected that the office had nothing to do with the automatization of chemical industries, but they chose not to say anything out loud about the true activity of the office. Now it has all changed.

"Our employees are working for space research," says chief designer A. Konopatov, a corresponding member of the USSR Academy of Sciences. "We design rocket engines and we build them together with the Voronezh mechanical plant. All the rockets that took our cosmonauts into space orbits had our engines. It was with our immediate participation that the hydrogen engine of the 'Energiya' booster rocket for the 'Buran' spaceship was built."

Conversion came to "Khimavtomatika" as well. This means that the office should cut down on its basic work and transfer to producing some "down-to-earth" things. But which?

The institution is involved with powder metallurgy. They had some sophisticated foreign-made equipment installed for that. Its cost runs to six-digit figures. They produce parts of the most complex shapes and of perfect quality out of ultra-pure titanium- and nickel-base alloys. The products from Voronezh displayed last year at the international exhibition-fair in Leipzig were awarded a gold medal.

So it is quite impossible to change the production type of this facility, no matter how much you wish it. They can only continue to do what they are doing now. If they decide to make pressing irons or meat grinders they will have to dismantle the existing equipment and install new machines. The losses for the country in such a case cannot be covered by any consumer goods even if they are priced as high as jewelry. It is obviously sensible to preserve the powder metallurgy equipment and open the institution to orders from outside. After all, the cooperation between the secret research and production facilities and open enterprises can be included in the conversion, too.

However, this does not seem to be working either. Evidently, the defense industries have become so advanced in their science and technology that their techniques can be used widely only at similar levels. In our conditions it also means similar types of industries. They can be used anywhere else only as an exception. As the orders are few and they have cut down on their main production the capacities in the ultra-modern institution are not fully employed. Thus the conversion has already brought losses.

The question arises: What can prevent us, with our current acute shortages of hard currency, from selling basic products? After all, rocket engines are also a commodity. We cannot treat the conversion as the mandatory destruction of the well-settled production process and do it just for the sake of converting. Surely, the countries doing space research would be interested in our engines.

"Why not?" replied A. Konopatov with a question. "To export rocket engines is to guarantee a respectable way of

earning hard currency. It would bring profits to us and to the country and would not damage the defense of our country. But this issue is beyond my reach. It should be dealt with at the government level."

I remembered the words of the chief designer walking around the building where the design office has installed a knitwear factory. The rocket engine testers demonstrated the ladies' sweaters they have learned to make. As I handled the uncomplicated items I thought of the amounts of the most fashionable clothes and shoes, state-of-art appliances, and other rare commodities we could have bought with the money received from the sale of just one engine.

Funding For 'Lomonosov' Space Project Cancelled

LD1406204390 Moscow TASS in English 1803 GMT 14 Jun 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow June 14 TASS—The implementation of a unique space project, which could aid the work of astronomers for the next 50 years, has been shelved.

The project was not particularly expensive for a space programme. It would cost only R120 million and some 50 million U.S. dollars (if foreign investors are found).

"According to the project, which is named after the great Russian scientist Mikhail Lomonosov, it was planned to launch a Soviet space observatory between 1995-1996. The observatory was to create a high-precision coordinate system of the skies," Sternberg Astronomy Institute scientist Yevgeniy Sheffer said.

"The astronomic satellite would let astronomers create a common scale that could be far more precise than any existing one. Such a long-term coordinate system could be used for 30 to 50 years. It is badly needed in astrometry, geodynamics, geodesy and solar system studies.

"The financing of the project has been stopped. We are now trying to switch the project to a commercial basis. We suggested that scientists from Italy, West Germany and the European Space Agency participate in the joint research.

"Our proposal will be discussed at the congress of the Association of Space Explorers, due in the Netherlands in July. We were invited to the congress to acquaint its participants with the project," he said.

Disarmament Raised in UN Space Committee Meeting

LD1506091190 Moscow TASS in English 0820 GMT 15 Jun 90

[By TASS correspondent Nikolay Maslov]

[Text] United Nations June 15 TASS—The United Nations Committee on the Peaceful Uses of Outer Space, which unites 53 nations, has concluded its 33rd session here.

Discussions at the session focused on ways to cooperate and find solutions. The committee discussed scientific, technical and legal aspects of the use of nuclear sources of energy in outer space, geostationary orbits, space transportation systems, the probing of the earth from satellites, and indirect advantages from the use of space technology.

The committee adopted by consensus recommendations for the preservation of outer space for peaceful purposes. Delegations from developing countries and the Soviet Union called for making the committee and the conference for disarmament mutually supplementary.

The United States and some other countries took a different stand, seeking to block discussion of disarmament issues by the committee. They claimed these issues were not within the committee's competence.

However, the Soviet delegation said the treaty on space, worked out by the committee in 1967, contained disarmament aspects. It bans the deployment of nuclear and other weapons of mass annihilation in outer space.

The Soviet delegation reiterated its proposal to set up a world space organisation and to establish large-scale international cooperation in the peaceful exploration of outer space.

The session's recommendations, which are to be considered by the UN political committee and submitted to the General Assembly, emphasise the need to extend the utilisation of space technology for the benefit of all mankind.

TASS Reports Bush Decision To Allow U.S. Satellites on Soviet Rockets

LD0907071490 Moscow TASS in English 0654 GMT 9 Jul 90

[By TASS correspondent Sergey Kuznetsov]

[Text] New York July 9 TASS—The Bush administration has decided to allow American commercial satellites to be launched on Soviet rockets, THE NEW YORK TIMES reports on Sunday, quoting government and industry officials.

Launchings of satellites to be made by companies in the United States and other countries are planned to be carried out from a base in northern Australia.

Under the 500-million-dollar project worked out by an Australian commercial venture, the Cape York Space Agency, the Soviet Union "would supply rockets and engineers but would not own a share in the venture," THE NEW YORK TIMES said.

The Cape York station will be operated by a division of the United Technologies Corporation. The newspaper says the first launchings could take place in 1995.

"The Reagan administration had never considered letting the Soviet Union launch American satellites, but warming relations between the two countries made the Australian proposal palatable to the Bush administration," the newspaper said.

"The project provides a major opportunity for the Soviet Union to expand its international space business."

Space Cooperation Pact Signed With European Space Agency

LD2504203590 Moscow TASS in English 1849 GMT 25 Apr 90

[Text] Paris April 25 TASS—The USSR Government and the European Space Agency (ESA) today signed an agreement on cooperation in the exploration and use of space for peaceful purposes.

The agreement was signed at the ESA Paris headquarters by Soviet Ambassador to France Yakov Ryabov and the agency's Director General Reimar Lust.

Speakers at the signatory ceremony unanimously noted that the document was of an exceptional nature. It is the first time that the Soviet Union and West European countries, represented in the ESA, has concluded such a broad treaty, which provides for a vast spectrum of joint scientific-technical research.

The research efforts include work to explore the solar-terrestrial interaction, the joint study of the surface and the atmosphere of the Earth using satellite systems, a program to peer into microgravitation, and astrophysical research.

Experts beleive that the agreement will enable Soviet and West European space researchers to pool their efforts, giving a fresh boost to the development of space science.

Addressing those present at the ESA headquarters, Lust stressed that the European Space Agency wants to expand Soviet-West European ties for the peaceful use of space. "We are interested in this, because the USSR is the sole country in the world that has a permanent orbiting station in space," Lust said.

"The program to study microgravitation, an all-important one in preparing future space flights, is feasible exactly at this station. I can already picture an astronaut, representing the ESA, working with colleagues from the USSR at the Soviet station.

"We have already witnessed cooperation between the USSR and a separate West European country, France, in part. The new Soviet-West European agreement signals a big step forward in scientific-technical, practical and political terms," Lust said.

Other speakers pointed out that the document signed would promote European cooperation in peaceful space exploration, which fits well into the process of detente on the continent and contributes to building a common European home and a confederation of European nations.

Both the Soviet Union and Western Europe, they said, have already amassed vast experience in space exploration and have ambitious plans, in which there is much in common. For instance, both sides are engaged in the development of space shuttles (the Soviet shuttle Buran has already made its first test flight). West Europeans are also developing their space station "Columbus" and the powerful booster rocket "Ariane-5".

All this, in the opinion of both sides, opens good prospects for increasing European cooperation in the interests of all peoples living on this continent and promotes peace, stability and mutual understanding in Europe.

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